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December, 1937

AIR MINISTRY

Airworthiness Handbook *for* Civil Aircraft

VOL. II
INSPECTION SECTION

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FOREWORD

PART I.—GENERAL

1. **Application of volume.**—(i) This volume of the handbook is issued as a guide to the inspection of Type aircraft that are designed, constructed or intended to carry more than ten passengers for hire or reward, or that have a maximum permissible weight of more than 10,000 lb. It also covers the inspection of a modification affecting safety on its first being incorporated in any Type or Subsequent aircraft in either of the classes indicated above.

(ii) The handbook is intended to be read in conjunction with the Air Navigation (Consolidation) Order, 1923, and the Air Navigation Directions, 1936 (A.N.D.13) (or any Orders, Regulations or Directions replacing the same) as in force for the time being. These are purchasable from His Majesty's Stationery Office, Adastral House, Kingsway, London, W.C.2, or through any bookseller.

2. **Inspection requirements.**—The general requirements stated hereunder are taken from the Air Navigation Directions, 1936 (A.N.D.13), Section II (C), para. 19. These requirements are amplified in the leaflets which form the remainder of the volume.

" (*a*) Inspection of type aircraft will be carried out by the Secretary of State, but the inspection of all details and components of such aircraft shall be carried out by the constructor, who shall provide adequate inspecting staff for this purpose. In addition, each component shall be finally inspected and approved by the Secretary of State.

(*b*) Constructors shall notify the Under Secretary of State, Air Ministry, London, W.C.2, seven days before commencing work on any part of the aircraft the inspection of which is necessary during process of construction.

(*c*) All materials used in the construction of the aircraft shall be in accordance with the specifications approved for the type design and every batch of such material shall be proved to comply with such specification by suitable examination, sampling and testing by approved methods.

(*d*) Every detail and part must be proved by the constructor's inspecting staff referred to in (i) of this paragraph by suitable process of testing and inspection to conform strictly to the approved type design. The constructor's inspecting staff shall stamp, or otherwise provide means for the identification of, each detail and part approved by them for incorporation in the aircraft, in such a way that the individual responsible for such approval can subsequently be identified.

(*e*) Only details and parts which have been approved in accordance with (*d*) of this paragraph, or details or parts for which special " concessions " have been granted as laid down in paragraph 21, may be issued by the constructor to the shops for assembly into components.

(*f*) The constructor shall maintain an efficient process inspection during the work of assembly and record the progress of such inspection for each component. Every component shall be finally inspected and approved by a qualified member of his inspection staff, who shall stamp the component in such a way that he may afterwards be identified as the person responsible, and shall also sign the inspection record.

(*g*) Operations such as heat treatment of steels, seasoning and conversion of timber, gluing of important parts, doping, etc., must be carried out by approved methods.

(*h*) The constructor shall ensure that all components and parts obtained from sub-contractors have been inspected and approved in accordance with these conditions.

(*i*) The constructor (of the aircraft or engine, as may be arranged) shall ensure that all engines have been inspected and approved in accordance with these conditions and have undergone, to the satisfaction of the Secretary of State, such tests as may be required by him. The constructor shall provide adequate facilities for these tests.

(*j*) The constructor shall satisfy the Secretary of State that the specified instruments and equipment have been manufactured, and any repairs thereto executed, under approved conditions, and that such instruments comply with current specifications approved by him.

(*k*) The aircraft constructor shall ensure by suitable inspection that all engines, instruments and parts (including wiring for electrical equipment other than wireless apparatus) that are fitted into the aircraft are so installed as to function correctly, and, if wireless telegraphy or wireless telephony apparatus is fitted, that the installation of such apparatus, including bonding and screening, is not such as to prejudice the operation of the aircraft and is in conformity with such requirements as may have been laid down by the Secretary of State. The individuals responsible for such inspection shall be indicated by signatures on the inspection record referred to in (vi) of this paragraph.

(*l*) On completion of the construction of the aircraft and of flying trials under para. 24, but before the carrying out of any official flying trials under para. 25, a final inspection of the aircraft as regards its fitness for flight shall be made by the Secretary of State.

(*m*) On completion of the whole of the inspection operations specified above, the constructor shall forward to the Secretary, Air Ministry, London, W.C.2, a summary of the inspection record of the aircraft. For this purpose, A.M. Form 1221 (copies of which can be obtained on application) shall be used. All the particulars required by the Form must be given."

3. **Numbering of leaflets.**—According to its subject, each leaflet is numbered in the series 1–99 (dealing with the inspection of air frames) or 100–199 (dealing with the inspection of engines) or 400–499 (dealing with the inspectional control of processes) or 500–599 (dealing with the inspection of instruments and equipment). The number is the same as that of the corresponding Inspection Instruction applying to aircraft intended for the Royal Air Force. The gaps in the numbering are due to the facts that (i) many of the Inspection Instructions do not apply to Civil aircraft, and (ii) instructions for the inspection of materials have been excluded ; it should rarely be necessary to consult the latter (notwithstanding Part II, para. 1, of this Foreword) as the essential information will usually be given in the relevant specifications.

4. **References to handbook.**—Reference to any particular portion of the handbook should be made by quoting the volume (i.e. I or II), leaflet, paragraph (or sub-paragraph) and line number.

5. **Amendments.**—The book will be kept up to date by amendments issued at irregular intervals. Normally the amendments will consist of replacement sheets and will include (where necessary) a marginal note indicating the new clauses and their dates of application. Every such amendment sheet will be marked " This sheet issued................(date) with A.L. No............. to A.P. 1208 ". It can be assumed that every sheet not so marked formed part of the 1937 edition of A.P. 1208. These amendments will be purchasable from His Majesty's Stationery Office or through any bookseller. On receipt of a deposit of five shillings His Majesty's Stationery Office will undertake to post to the applicant one copy of all amendments as and when issued, up to the value of the deposit. Normally the publication of each new amendment will be closely followed by the issue of a Notice to Aircraft Owners and Ground Engineers, notifying all concerned that the amendment is on sale. The series of amendment sheets will be common to both volumes of the handbook.

6. **References to publications.**—References to publications are to be interpreted as implying the latest editions of those publications except when the context implies otherwise.

7. **Notices to Ground Engineers.**—Frequent references are made throughout this handbook to Notices to Aircraft Owners and Ground Engineers. A consolidated booklet of all such Notices remaining in force on the 31st December each year is issued towards the end of February of the year following. Copies of this booklet can be purchased from His Majesty's Stationery Office or through any bookseller. Applications for copies of Notices to Aircraft Owners and Ground Engineers issued during the current year should be addressed to the Under Secretary of State, Air Ministry (C.A.P.), London, W.C.2, and should include a statement as to the purpose for which the Notices are required.

AIR PUBLICATION 1208
Vol. II
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AIRWORTHINESS HANDBOOK FOR CIVIL AIRCRAFT

The amendments promulgated in the under-mentioned amendment lists have been made in this publication.

Amendment List		Amendments made by	Date
Number	Date		
3	5/1938	E. L. Richardson	10. 9. 38

A 1, A 39, A 31,
E 132 A 34
412.

This sheet issued May, 1938,
with A.L. No. 3 to A.P. 1208.

Insert this sheet immediately in front of the Index to Vol. II, Inspection section

MINOR CORRECTIONS TABLE No. 3

VOL. II.—INSPECTION SECTION

Inspection Leaflet 7, Para. 4

Line 2. After the first sentence, *insert* " The same test must also be made on each one-piece spar, sufficient timber for the purpose being allowed when the spar lengths are cut from the planks." (691500/37.)

Inspection Leaflet 110

Renumber the leaflet as 421. (513668/36.)

Inspection Leaflet 141

Renumber the leaflet as 430. *Add* at end of para. 2 (iii) " *See* Inspection Leaflet 407 ".

(689426/37.)

This sheet re-issued May, 1938,
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PART II.—BASIC PRINCIPLES OF INSPECTION

1. **Supplies of material.**—Supplies of material will normally be subject to the conditions applying in the case of aircraft intended for the Royal Air Force, i.e., their inspection, identification and release must be in accordance with such specifications and Inspection Instructions as are relevant.

2. **Material at aircraft works.**—Material received at an aircraft works must be placed in a " bonded store " as soon as the inspector has correlated it with the release note or other evidence of prior inspection. If for any reason this evidence is missing the material must be held in a " quarantine store " until either the release note (or its equivalent) comes to band or the material has been completely re-inspected.

3. **Identification of material.**—A job card or similar document, indicating the relevant release note or other evidence of prior inspection, must be started when material is issued from the bonded store to the workshops. The records of subsequent inspection shall enable the source of the material and the various inspectors concerned with any part made therefrom to be identified at any time.

4. **Inspection.**—(i) The value of the inspection of an aircraft depends :—

(*a*) upon the skill and care with which each inspection operation is performed ; and

(*b*) upon every detail and assembly being systematically followed through from the raw material to the finished product.

(ii) The grant of a certificate of airworthiness can be recommended only when the inspector is fully satisfied that each operation in the complete series has been performed efficiently.

5. **Inspectors' stamps.**—(i) Every inspector must be provided with stamps for marking the materials or articles which he will be called upon to inspect. The identity of the inspector must be ascertainable from these stamps.

(ii) The inspector's mark on an article or on the inspection document relating to an article signifies that the article, when examined by the inspector, was found to be in a satisfactory condition.

(iii) Before passing any article the inspector must be satisfied that :—

(*a*) the material complies with the requirements specified on the approved drawings (*see* Vol. I, Design Leaflet B.1, paras. 4 and 5) and has received the requisite process treatment ;

(*b*) the part is dimensionally accurate and satisfactory as regards its finish ;

(*c*) the material has not been subjected to any improper treatment and is free from defects.

(iv) The inspector must also satisfy himself that all detail parts are properly fitted and secured during the assembly of an aircraft, and, finally, that the complete aircraft is in all respects airworthy.

By direction of the Secretary of State for Air,

Donald Banks

Permanent Under Secretary of State for Air.

INSPECTION LEAFLET 8

INSPECTION OF ANODIC OXIDATION PROCESS FOR THE PROTECTION OF ALUMINIUM AND ALUMINIUM ALLOYS, INCLUDING DURALUMIN

1. General.—The inspection of the anodic oxidation process will consist primarily of a general examination of the plant used and methods adopted for its operation, together with periodic tests of the electrolyte, visual examination of the finished parts, and, in the case of built-up parts, an examination of a control specimen treated simultaneously with the actual parts. The following instructions must be observed by the inspector when supervising the control of the process.

2. Preparation of parts prior to dipping.—The inspector must ensure that adequate arrangements are made for cleaning the aluminium, duralumin or other aluminium alloy parts with petrol, benzol or solvent naphtha, and for finally washing with hot water and drying immediately prior to treatment in the oxidation bath. The inspector must be satisfied that all welded aluminium fittings are kept in contact with boiling water for 30 minutes before anodic treatment to remove the flux residues and thus eliminate the risk of severe pitting occurring during the treatment.

Notes.—(i) If a salt bath has been used for heat-treatment the parts must be quenched in cold water and all traces of salt removed by washing thoroughly in running water.

(ii) With built-up fittings the surfaces to be joined are to be scratch-brushed or buffed before riveting. These fittings must be immersed in boiling water immediately before they are placed in the anodic bath.

3. Composition of bath.—The inspector must periodically forward samples of the electrolyte to an approved test house for the chloride content to be determined ; this must not exceed the equivalent of 0·20 grm. sodium chloride per litre. The electrolyte must consist of a solution (using distilled water) containing 3 per cent. of chromic acid (CrO_3, chemically pure). The use of the local water supply can be approved only when the inspector has satisfied himself as to its freedom from chlorides by means of tests at an approved test house. To compensate for evaporation the concentration of the solution must be maintained by the use of distilled water.

Notes.—(i) The solution will function satisfactorily with a strength of 2½ per cent. of chromic acid ; a low limit will be indicated by the appearance of the treated parts. It is advisable that the content of chromic acid be checked periodically by analysis.

(ii) Arrangements must be made to prevent the solution being contaminated by chlorides or foreign matter. A hood should be arranged to cover the bath, especially in marine districts. Before treating parts which have been welded, care should be taken, by thoroughly washing them, to ensure that they are free from flux.

(iii) Suspended foreign matter is liable to collect along the joints of built up fittings ; the contents of the bath should therefore be filtered occasionally or allowed to settle and then decanted.

4. Control of process.—The inspector must satisfy himself that the operator maintains an adequate control of the temperature of the bath, current density and voltage.

Notes.—(i) The limits of temperature variation are 40° C. ± 4° C., and adequate precautions are to be taken to ensure that this variation is not exceeded. Temperature control should be exercised throughout the bath, especially in the interior of hollow or partially enclosed parts under treatment.

(ii) The bath should be provided with some form of mechanical stirrer and, in addition, with some heating and cooling device to keep the temperature within the prescribed range. A system of pipes running the entire length of the bath may be used for heating and cooling by passing steam or cold water through them alternately. Electrical or external heating may be employed at the start as sufficient heat is usually generated during the process to keep up the temperature ; in this case only cooling arrangements would be required. Overheating of the bath may cause pitting at the water-line of the solution, particularly in the absence of sufficient agitation. Local boiling of the solution at the water-line is an indication of overheating. Violent agitation of the solution, on the other hand, is unnecessary.

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INSPECTION LEAFLET 11*

INSPECTION AND TESTING OF WHEEL BRAKES FOR AIRCRAFT

1. **General.**—The inspection of an aircraft wheel brake installation will comprise an examination to verify that the various parts thereof have been manufactured and installed in accordance with the relevant drawings and a test to prove that it functions correctly.

2. **Details.**—The inspector must verify that every detail has been proved to comply with the relevant requirements as regards materials, dimensions and workmanship and has passed such proof loading and/or pressure tests as may have been specified.

3. **Experimental systems.**—Except when it is of an experimental type and is either to be temporarily fitted (solely for the purpose of testing the system) to an otherwise non-experimental aircraft or incorporated in an experimental aircraft (in both of which cases the inspector must obtain from the constructor a certificate that the system has been approved for installation in the aircraft), a braking system which has not been inspected in complete detail may not be installed.

4. **Installation.**—The inspector must satisfy himself that the installation is in accordance with the drawings generally and in particular that :—

(i) the control lever or pedals which operate the brakes are correctly positioned ;

(ii) all operating rods, cables or pipe lines are adequately supported, and disposed so as to preclude chafing or wear ;

(iii) there is no restriction on the travel of the moving parts and no risk of such parts fouling others ;

(iv) all bolts, pins and adjusting devices are correctly locked.

5. **Tests (Type aircraft installations only).**—(i) The brakes are to be thoroughly run in on their own drums, this being done (when other means are not available) by taxying the aircraft for 20-30 minutes with the brakes partially applied and intermittently putting them full on.

(ii) The aircraft must then be jacked up with the wheels clear of the ground for tests to establish that the brake torque is in accordance with the requirements specified by the D.T.D. representative and that the following requirements are also satisfied.

(*a*) With the brakes off, each wheel shall be turned by hand through 360° and shall not bind or rub in any position. The test shall be repeated after the brakes have been applied and released, to show that there is no tendency for the brakes to stay on ;

(*b*) With the brakes partially applied, each wheel shall again be rotated and there shall be no " hard spots ", i.e. the braking effect must be uniform ;

(*c*) It shall be verified that the full braking effect is such that the brakes will not lock the wheels against a specified torque X and that the brakes will lock the wheels against a specified torque Y.

(iii) The magnitude of the torque X will usually be stated on the general arrangement drawing for the brake installation, and, unless otherwise specified, Y shall be taken as equal to 0·8 X.

(iv) An approved arrangement for applying torque to an undercarriage wheel is illustrated in fig. 1 and described below :—

A light wooden frame, shaped at one end to fit the tyre and with a hook for the attachment of weights or a spring balance at the other end, is temporarily secured to the wheel by adjustable straps. The frame may consist of two wooden battens (each approximately 2½ in. square in cross-section) joined by plywood sides. It should be of some convenient length, say, 5 ft. approximately. The axis of the frame must always be horizontal when observations are being made.

(v) The air or oil pressure, spring tension, clearances, etc., corresponding to the required torque must be recorded, and shall be standardised for subsequent aircraft.

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* This leaflet will take effect as from 1st May, 1938. (691665/37.)

INSPECTION LEAFLET 12

INSPECTION OF AIRSCREWS (WOOD)

1. General.—The inspector is to verify that all airscrews are manufactured in accordance with the drawing and/or design requirements and that the material employed in their manufacture conforms with that specified by such requirements. To this end suitable records are to be kept for each airscrew, giving particulars of all waiting periods, dimensions, balance, finish, etc.

2. Laminae.—The inspector is to verify that :—

(i) The timber employed is that called for on the approved drawing and has been stored under the specified conditions for the required period prior to conversion.

Note.—Moisture tests must be made to ensure that the content is not above that specified, and impact tests must be made on representative samples taken from each plank from which laminae are cut. The determined values should be recorded. An examination should also be made of every lamina to ensure that the direction of grain conforms with the requirements specified.

(ii) There is no jointing of any laminae other than that permitted by the design.

(iii) The laminae are of the correct thickness to give the required number of laminations in the finished airscrew.

3. Assembly of laminae and cementing.—The inspector is to verify that :—

(i) Before assembly begins all laminae have been stored for the specified period under atmospheric conditions comparable with those of the cementing room.

(ii) The cementing room is maintained at the temperature required for the particular adhesive employed.

(iii) The laminae are selected and arranged in such a manner as to ensure the best balance in the complete assembly.

(iv) The surfaces of the laminae are clean and correctly toothed before cementing.

(v) An approved method of clamping is employed.

(vi) A suitable flat base is provided to give continuous support over the entire length of the airscrew.

(vii) Only approved cements are used.

4. Inspection of rough-shaped block.—(i) The inspector is to verify that the waiting period prior to rough shaping has been allowed to elapse. After rough shaping, boring and drilling have been completed the inspector is to verify that :—

(*a*) the laminae used have been previously approved ;

(*b*) the assembly and cementing processes have been satisfactorily carried out ;

(*c*) the shaped block is free from defects in joints and timber.

(ii) On approval of the rough-shaped block, the inspector will impress his stamp in the position indicated in sub-para. 8 (ii).

5. Inspection in the white.—Final shaping having been completed, the inspector is to verify that :—

(i) the specified waiting period has elapsed between rough and final shaping ;

(ii) the whole of the cemented joints are satisfactory ;

(iii) the timber is free from checks, shakes and other defects ;

INSPECTION LEAFLET 7

INSPECTION OF AIRCRAFT TIMBER PARTS DURING MANUFACTURE

1. All timber used for the manufacture of aircraft main structural members must, before being passed to the shops, be tested for:

(i) freedom from brittleness;
(ii) the correct moisture content;
(iii) the specified density.

In general, main structural members may be taken to include all solid or laminated spars; flanges and webs of built-up spars; longerons; undercarriage, interplane, fuselage and wing compression struts.

2. Subsidiary timber parts need not be subjected to these tests but shall be visually examined for quality and freedom from deleterious defects on completion of manufacture.

3. (i) In the event of a maker desiring to adopt only the higher grade for all purposes, arrangements whereby only timber which has satisfied para. 1 above is permitted to enter the shops will be considered an adequate safeguard, and no special subsequent identification will be necessary.

(ii) In cases in which both grades are being used simultaneously for manufacture, definite identification of the higher grade of timber is essential. The means of identification may be either identification markings on the scantlings themselves or an adequate, fool-proof system of documentary identification (e.g., entries on shop progress cards).

4. The first test referred to in para. 1 *must be made on each plank* by one of the methods described in Appendix I.* Test (ii) must be made on specimens taken from selected planks, representing a batch or parcel of planks which the inspector has every reason to believe are consistent with regard to seasoning and moisture content. The method of making this test is explained in Appendix II. Test (iii) *must be made on each plank* in accordance with Appendix III. In addition, standard test specimens, 48 ins. × 2 ins. × 1 in., shall be periodically selected and submitted for test at an approved test house for verification of the quality of timber so far as its compression strength and modulus of elasticity are concerned. Records of the results of these tests must be maintained for all planks and for batches of timber so dealt with.

* The same test must also be made on each one piece spar, sufficient timber for the purpose being allowed when the spar lengths are cut from the planks (691500/37)

5. The inspector is authorised to use discretion in accepting subsidiary timber parts, such as fairings, packing blocks, etc., the strength of which is unimportant, and which do not comply with the specification as regards slope of the grain or other characteristics, provided that the serviceability of the parts is not affected. Accepted parts must be marked with the letters S.P. in block enclosed in a border impressed in proximity to the usual inspection stamp.

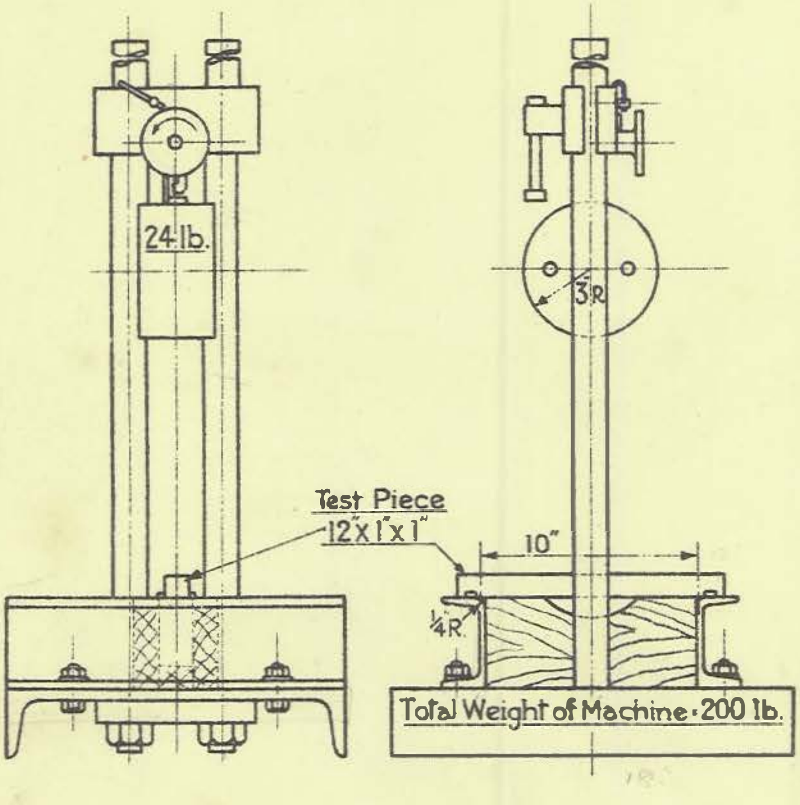

Fig. 1. (Inspection Leaflet 7)

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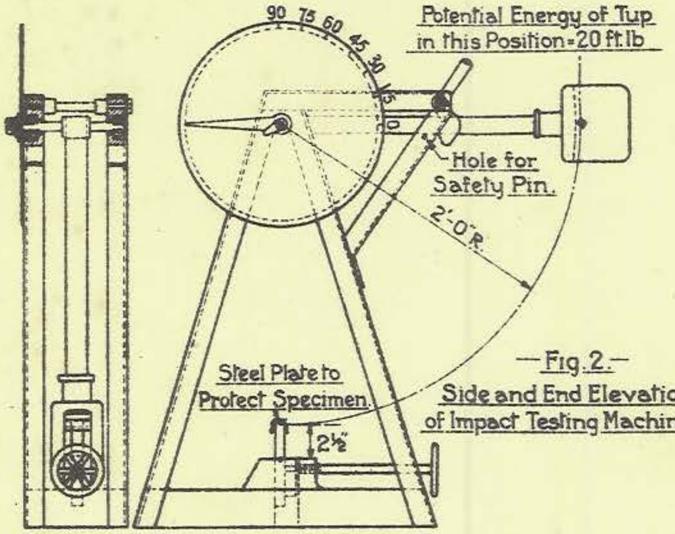
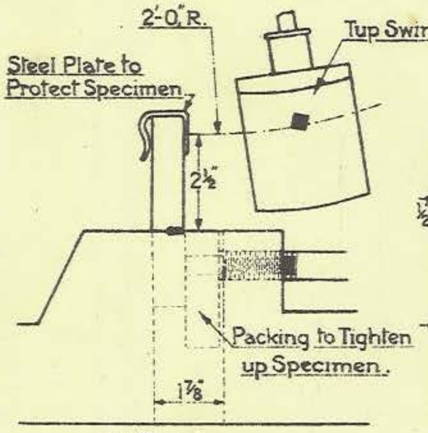
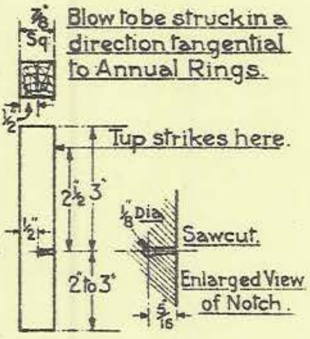
Malby & Sons, Lith.


90
75
60
45
30
15
0
Potential Energy of Tup in this Position = 20 ft.lb
Hole for Safety Pin.
2'-0" R.
Steel Plate to Protect Specimen.
2½"

—Fig. 2.—
Side and End Elevations of Impact Testing Machine.


2'-0" R.
Tup Swinging at Radius of 2 ft.
Steel Plate to Protect Specimen.
2½"
Packing to Tighten up Specimen.
1⅞"

—Fig. 3.—
Enlarged View Showing Test Piece in Position in Testing Machine.



—Fig. 4.—
Standard Test Piece.

Impact Testing Machine.

Note: When scale is marked in degrees as shown, work expended in breaking specimen = $20 \sin \alpha$ (α = Reading on scale at which pointer comes to rest.

2044

(Inspection Leaflet 7).

Final inspection of completed airscrew.

Ref.	Stage.

7. Final inspection.—(i) During the final inspection of an airscrew it is to be verified that :—

(*a*) the inspection records indicate that the airscrew has satisfactorily passed all previous inspection stages ;

(*b*) the final protective coating is dry, and the requisite standard of finish has been obtained ;

(*c*) no distortion of the airscrew has occurred subsequent to inspection under sub-para. 5 (iv) ;

(*d*) the airscrew is correctly balanced ;

Note.—The airscrew must be within the specified limits for balance in any position in the plane of rotation.

(*e*) the standard hub, with all bolts, assembles satisfactorily on the boss ;

Note.—If spigoted nuts are used they must be screwed up sufficiently to prove that they will enter correctly in the holes in the hub plate.

(*f*) all specified identification markings have been correctly applied.

(ii) After satisfactory completion of the above inspection processes, the final inspection stamp is to be impressed in the position indicated in sub-para. 8 (ii).

8. Inspection stamping.—(i) For the purpose of ready reference, the inspection processes detailed in this leaflet and the various stages at which inspection stamps are to be applied are tabulated below.

(ii) Unless otherwise specified, inspection stamp impressions are to be located between the boss and the root section of the blades in a position where they will not be obscured by the flange of the engine hub or the spinner.

Note.—Particular care must be taken to ensure legibility of the stamp impressions.

9. Repaired airscrews.—(i) When an airscrew is re-sheathed the screws and rivets are to bite into fresh timber. A rubbing is to be taken of the old holes in the blades to verify that the new holes for the screws and rivets are at least $\frac{1}{4}$ in. away from the existing holes.

(ii) Major repairs to an airscrew, such as re-covering with fabric, re-sheathing, etc., are to be indicated by an additional inspection stamp placed adjacent to the group of stamps applied during manufacture, together with the letter " R," and preferably two numbers indicating the month and year during which the repair has been effected. (Thus, " R.2/33 Symbol " would indicate a repair carried out during February, 1933.)

(iii) Each subsequent repair is to be indicated by similar date and inspection stamps.

INSPECTION LEAFLET 16

INSPECTION OF AIRCRAFT OIL COOLERS

(Vickers-Potts and Blackburn types)

1. General.—Oil coolers which are embodied in the aircraft installation and are not an integral part of the engine are to be regarded as components. Their inspection is to proceed as follows.

2. Material.—The inspector is to verify that :—

(i) the materials used in the manufacture of the detail parts are in accordance with the relevant drawings and/or design requirements ;

(ii) all soft solder used is Grade B to B.S. Specification No. 219–1932, or as specified on the drawings ;

(iii) an approved soldering flux has been employed.

3. Assembly of details.—(i) *Fins.*—The inspector is to verify that :—

(*a*) the various detail parts embodied in the assembly have been previously inspected and approved ;

(*b*) the top and bottom halves of the fins are efficiently tinned all over, and sufficient material has been left on the top half to ensure a sound joint when the edge is flanged over ;

(*c*) the riveting together of the two halves of each fin, and the soldering of the rivets, are satisfactory ;

(*d*) the soldering of the joint uniting the two halves of each fin has been efficiently done, and is such that the face of the flange presents an unbroken surface ;

(*e*) all traces of flux have been removed by flushing with hot water, and the fins dried by hot air.

Note.—After inspection of the above processes, the inspector will impress his acceptance stamp on the completed fin in accordance with sub-para. 8 (i).

(ii) *Relief valve.*—The inspector is to verify that :—

(*a*) the various detail parts embodied in the assembly have been previously inspected and approved ;

(*b*) the relief valve is free and fits correctly on its seating.

(iii) *Relief valve lifting gear* (*where fitted*).—The inspector is to verify that :—

(*a*) the various detail parts embodied in the assembly have been previously inspected and approved ;

(*b*) the lifting gear works freely, and the full amount of travel, as shown on the appropriate drawings, is obtained.

4. Test of details.—(i) *Fins.*—On completion of all workshop processes, each fin is to be tested with an approved mineral oil at a pressure of 25 lb. per sq. in. and a temperature of not less than 40° C. for not less than 15 minutes.

Note.—After the fin has passed this test and has been finally inspected, the word " Tested " and a second inspection stamp are to be impressed thereon, in accordance with sub-para. 8 (i).

INSPECTION LEAFLET 17

INSPECTION OF AIRCRAFT FLYING CONTROLS

1. **General.**—Since the safety of an aircraft is directly dependent upon the correct and adequate functioning of its flying control systems, every precaution must be taken by the inspector to ensure the correctness of each element forming part of such a system, in addition to ensuring the adequacy of its installation, functioning, and range of operation. As it is essential to avoid any possibility of a defect being overlooked, the duplication of final inspection called for hereunder must not in any circumstances be dispensed with.

2. **Details.**—The inspector must verify that :—

(i) all detail parts of control systems bear evidence of prior approval ;

(ii) all cables have been spliced in accordance with the relevant Inspection Leaflet ;

(iii) the made-up cables bear the necessary identification and inspection markings ;

Note.—Solid thimbles, dead eyes, or rollers may bear the necessary identification and inspection markings, but where tab-plates are used they must be so fitted and finally secured that fouling with the structure or other controls, etc., cannot occur.

(iv) all cables after splicing have been stretched by subjecting each to a tensile load of 50 per cent. of the normal breaking strength of the cable, prior to their installation ;

(v) all chains, with their end fittings attached, have been proof loaded to one-third of the ultimate load quoted on the drawings ;

Note.—For chains supplied by approved chain makers, the ultimate loads stated by the makers will be accepted as evidence of satisfactory ultimate strength ; for other chains it will be necessary to carry out a test to destruction on a sample cut from each separate length of chain supplied by the maker. Chain links must be joined by a positive method. Spring links are not approved.

(vi) every control wheel has been subjected to the following loads, irrespective of the size of aircraft for which it is intended :—

(*a*) Pull or push on wheel rim with the wheel supported as in use, the load being applied as 75 lb. at each end of the diameter which is normally horizontal	150 lb.
(*b*) A tangential force on wheel rim and applied between the spokes . .	75 lb.

(vii) where castings are used the special test requirements called for on the drawings have been fulfilled.

3. **Assembly of controls.**—The inspector must verify that :—

(i) the movement of each controlling surface is correct in relation to that of the operating control lever or handwheel ;

(ii) there is free and regular movement throughout the range of travel and throughout the system without undue backlash ;

(iii) cables are correctly aligned with pulleys and/or fairleads ;

(iv) the pulley guards are adequate to prevent cables leaving the pulleys ;

(v) there is no possibility of any part of the controls fouling or jamming with any adjacent part ;

(vi) there is no interference with sewing cord inside the covered surfaces ;

(vii) there is no possibility of tabs on cables or tie rods moving and fouling any adjacent member ; or where this possibility exists, that the identification tabs are removed, after inspection of the complete installation, and a record to this effect inserted in A.M. Form 1221 ;

INSPECTION LEAFLET 18

INSPECTION AND IDENTIFICATION MARKINGS ON AIRCRAFT DETAILS AND COMPONENTS

1. Inspection markings.—(i) Inspection markings on detail parts and components are for the purpose of denoting that such parts have satisfactorily passed authorised inspection, and are to take the form of legible impressions of a stamp. All stamps must bear symbols, numbers and/or letters whereby both the inspecting authority and the person responsible for the inspectional decision may be readily identified.

(ii) The presence of such markings on a detail part will signify that :—

(*a*) the material from which the part is made has been proved to be in accordance with specification ;

(*b*) all the necessary workshop processes involved in manufacture have been correctly carried out and that the condition of the material in the finished part is satisfactory ;

(*c*) its dimensions have been checked and found to be in accordance with the drawing and within the specified limits ;

(*d*) the identification markings are legible.

(iii) The presence of such markings on a component will signify that :—

(*a*) there is definite evidence that all the parts comprising the assembly, and the processes of manufacture involved, have been previously approved by an authorised inspector ;

(*b*) the materials used in the construction are free from defects as far as visual examination can determine ;

(*c*) the workmanship involved is such that the assembly is satisfactory as regards fit, truth and finish generally ; and

(*d*) the assembly is complete to schedule and has the necessary identification markings.

2. Omission of markings from small or fragile parts.—(i) The only exceptions that may be permitted to the above are :—

(*a*) Hardened metal parts which cannot be stamped.

(*b*) Small and delicate metal parts, such as bolts, nuts and screws of less than ¼ in. dia., which are liable to damage by stamping.

(*c*) Minor parts such as split and taper pins, and in the case of timber, minor wood packing blocks, rib flanges and the like details.

(ii) In these cases the following means of identifying inspection stages should be employed : sub-para. (i) (*a*), etching ; sub-para. (i) (*b*) and (*c*), tabs or labels affixed for the purpose of correlating inspection stages with book records.

3. Types of stamps.—(i) *Metal parts.*—The inspectional marking on small metal parts should be made with a ⅛-in. steel stamp. For larger metal details and minor assemblies a ⅜-in. stamp should be used. All inspection stamps are to be provided with a border, preferably of circular or oval shape ; triangular or square borders are not recommended as the corners may induce fatigue failure.

(ii) *Timber parts.*—For the marking of timber parts a rubber stamp of approved shape and marking should be used, together with a rubber date stamp for the purpose of ascertaining the age of the part at any subsequent time.

Components (*contd.*)

Components	Nature of markings		Position of marking
	Identification	Inspection	
Wing leading edge slats (new).	(*a*) Serial number consisting of firm's identification symbol followed by a number in 1-in. letters.	—	(*a*) Top surface of slat, outer end.
		(*b*) ⅛-in. metal stamp with date.	(*b*) Alongside (*a*).
Covered components (repaired), including fuselages.	—	(*b*) as for new components, but placed as indicated.	(*b*) On piece of three-ply, ash or other suitable timber, glued or bradded to spar over original stamp. In case of metal components, plate to be fastened over original plate, if any.
	(*d*) Serial number, preceded by repairing constructor's identification initial and letter " R."	—	(*d*) As for (*a*).
	(*e*) Original manufacturer's serial number.	—	(*e*) To be marked on spar by indelible pencil or the equivalent so as to be visible through inspection window.
	(*f*) Repairing constructor's identification initial and word " REPAIRED " stencilled on framework.	—	(*f*) On inside of end rib of framework before covering. (*See* fig. 1 for further information.)
Wing leading edge slats (repaired).	(*d*) Serial number, preceded by repairing constructor's identification initial and letter " R."	—	(*d*) Alongside that for new components.
	(*e*) Original manufacturer's serial number.	—	(*e*) Retained in original position.
		(*f*) ⅛-in. metal stamp with date.	(*f*) In proximity to original stamp followed by " R ".
Landing gear	(*a*) Serial number including constructor's identification initial.	—	(*a*) On outer face of starboard front strut.
		(*b*) Stencil inspection stamp with date.	(*b*) Alongside the serial number.
Oleo legs	(*a*) Serial number including constructor's identification initial.	—	(*a*) On brass plate sweated in a prominent position on outside of each leg but not on fairing.
		(*b*) Metal stamp.	(*b*) Alongside the serial number.
Interplane struts	No serial numbers are required.	One inspection stamp and date.	Stencil and date stamps about 12 in. from bottom of strut.
Tanks (fuel, oil and water)	(*a*) The word " Fuel," " Oil " or " Water," as case may be, and capacity of tank.	—	(*a*), (*b*), (*c*) and (*d*) on plate fixed to body of tank near filler cap.
	(*b*) Manufacturer's identification symbol or name.	—	—
	(*c*) Serial number and date.	—	—

7. Final inspection.—(i) During the final inspection of an airscrew it is to be verified that :—

(*a*) the inspection records indicate that the airscrew has satisfactorily passed all previous inspection stages ;

(*b*) the final protective coating is dry, and the requisite standard of finish has been obtained ;

(*c*) no distortion of the airscrew has occurred subsequent to inspection under sub-para. 5 (iv) ;

(*d*) the airscrew is correctly balanced ;

Note.—The airscrew must be within the specified limits for balance in any position in the plane of rotation.

(*e*) the standard hub, with all bolts, assembles satisfactorily on the boss ;

Note.—If spigoted nuts are used they must be screwed up sufficiently to prove that they will enter correctly in the holes in the hub plate.

(*f*) all specified identification markings have been correctly applied.

(ii) After satisfactory completion of the above inspection processes, the final inspection stamp is to be impressed in the position indicated in sub-para. 8 (ii).

8. Inspection stamping.—(i) For the purpose of ready reference, the inspection processes detailed in this leaflet and the various stages at which inspection stamps are to be applied are tabulated below.

(ii) Unless otherwise specified, inspection stamp impressions are to be located between the boss and the root section of the blades in a position where they will not be obscured by the flange of the engine hub or the spinner.

Note.—Particular care must be taken to ensure legibility of the stamp impressions.

9. Repaired airscrews.—(i) When an airscrew is re-sheathed the screws and rivets are to bite into fresh timber. A rubbing is to be taken of the old holes in the blades to verify that the new holes for the screws and rivets are at least ¼ in. away from the existing holes.

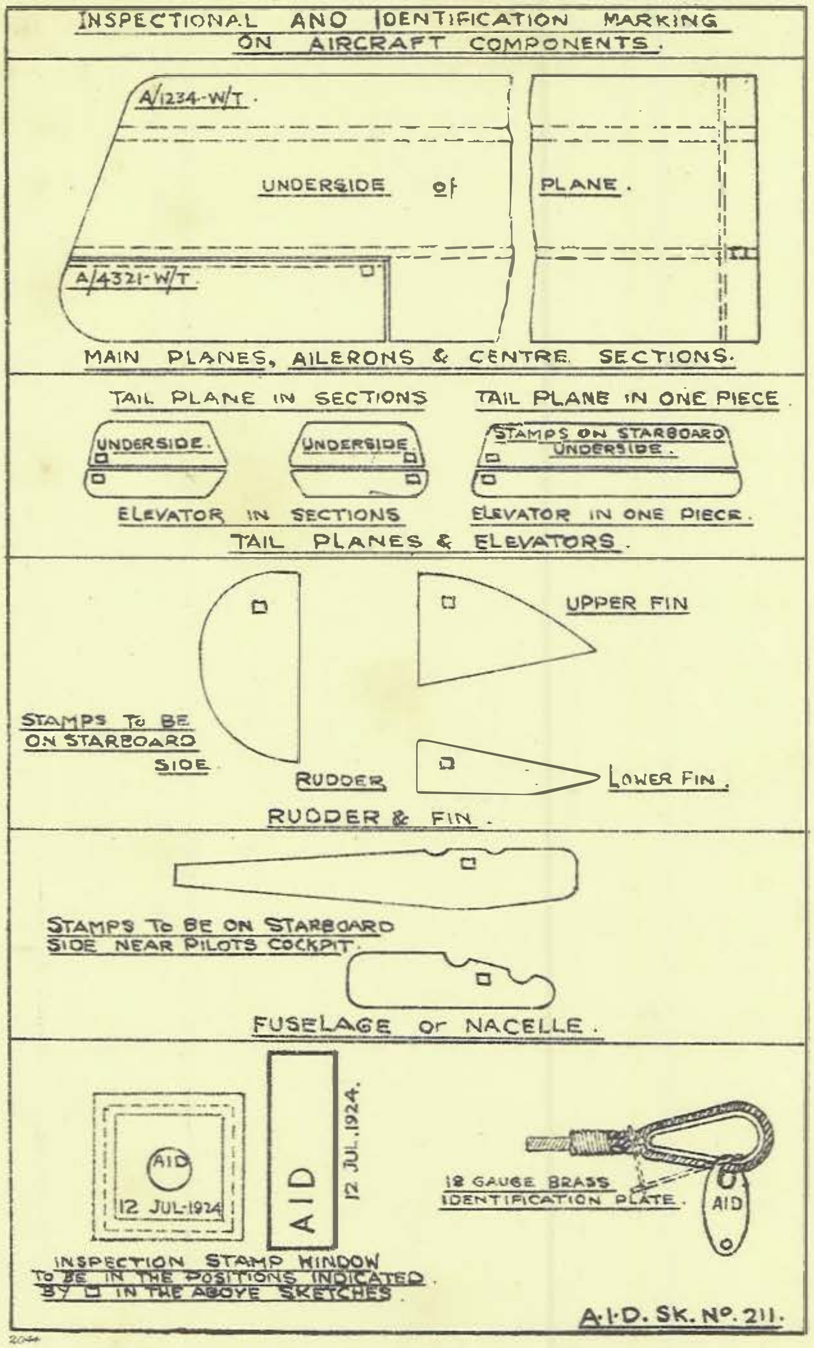
(ii) Major repairs to an airscrew, such as re-covering with fabric, re-sheathing, etc., are to be indicated by an additional inspection stamp placed adjacent to the group of stamps applied during manufacture, together with the letter " R," and preferably two numbers indicating the month and year during which the repair has been effected. (Thus, " R.2/33 Symbol " would indicate a repair carried out during February, 1933.)

(iii) Each subsequent repair is to be indicated by similar date and inspection stamps.

Components (*contd.*)

Components	Nature of marking		Position of marking
	Identification	Inspection	
Airscrews (wood)—*contd.*		(*d*) Two process stamps and one inspection stamp for completed airscrew.	(*d*) ⅜ in. metal stamp impressions grouped together in a position between boss and root section of a blade on face remote from engine where they will not be covered by flange of engine hub.
Airscrew blades (hollow steel).	(*a*) Serial number of blade.	(*b*) Inspection stamp for completed blade.	(*a*) and (*b*) on sleeve at root end of blade in a position in which they can be seen after assembly in hub.
Airscrews (duralumin)	(*a*) Drawing number. (*b*) Identification symbol and serial number.	— (*c*) Inspection stamp for completed airscrew.	(*a*), (*b*) and (*c*) on root end of blade in a position in which they can be seen after assembly in hub.
Airscrew blades (duralumin).	(*a*) Serial number of blade.	— (*b*) Inspection stamp for completed blade.	(*a*) On root end of blade in a position in which it can be seen after assembly in hub. (*b*) ⅜ in. metal stamp impressed alongside serial number in a position in which it can be seen after assembly in hub.
Power-plant accessories such as pumps, cocks, valves and filters.	—	(*a*) Inspection stamp. (*b*) Word " Tested."	—

Note.—When identification or inspectional markings are stencilled a fast colour should be used, and, where possible, subsequently varnished over.


INSPECTIONAL AND IDENTIFICATION MARKING ON AIRCRAFT COMPONENTS.
A/1234-W/T.
UNDERSIDE of PLANE.
A/4321-W/T.
MAIN PLANES, AILERONS & CENTRE SECTIONS.
TAIL PLANE IN SECTIONS
TAIL PLANE IN ONE PIECE.
UNDERSIDE.
UNDERSIDE.
STAMPS ON STARBOARD UNDERSIDE.
ELEVATOR IN SECTIONS
ELEVATOR IN ONE PIECE.
TAIL PLANES & ELEVATORS.
UPPER FIN
STAMPS TO BE ON STARBOARD SIDE.
RUDDER
LOWER FIN.
RUDDER & FIN.
STAMPS TO BE ON STARBOARD SIDE NEAR PILOTS COCKPIT.
FUSELAGE or NACELLE.
AID
12 JUL.1924
AID
12 JUL.1924.
12 GAUGE BRASS IDENTIFICATION PLATE.
AID
INSPECTION STAMP WINDOW TO BE IN THE POSITIONS INDICATED BY ☐ IN THE ABOVE SKETCHES.
A.I.D. SK. No. 211.

2044

Fig 1. (Inspection Leaflet 18).

INSPECTION LEAFLET 19

INSPECTION OF ELECTRICAL INSTALLATIONS IN AIRCRAFT

1. General.—The inspection of general electrical installations in aircraft will consist of :—

(i) a check or examination of all the various components, instruments and wiring comprising the various circuits, for correctness to specification requirements, drawing requirements, and standard of workmanship ;

(ii) an electrical test to ensure adequate insulation of all conductors ;

(iii) an electrical test to ensure perfect continuity through all the circuits ;

(iv) an operational test to ensure that all circuits respond to switch movements.

2. Visual examination.—In addition to the examination for compliance with installation drawings, wiring diagrams, specifications, and schedules as regards correct mark or pattern of components, instruments and size of cables, etc., and their relative disposition, the inspector must ensure that :—

(i) general service circuits are kept as remote as possible from other circuits (especially R/T and D/F circuits) to reduce risk of interference with W/T communications ;

Note.—In no circumstances should common ducts or runs be provided.

(ii) where aluminium or duralumin tubes or ducts are used for the accommodation of electric cables, they are suitably protected against corrosion ;

(iii) all wiring is suitably marked, as necessary, to facilitate identification ;

(iv) all cables are free from joints of any description, except where terminal blocks or other approved parts, adequately protected, are incorporated ;

(v) where cables having an absorbent covering are used and any parts of them are, or would be, likely to come in contact with the aircraft structure, such parts are separated from the aircraft structure by a non-hygroscopic medium (Systoflex or material of a like nature is suitable for this purpose) ;

Note.—Conduits or ducts are not regarded as part of the structure.

(vi) all cable ends have been properly prepared ;

(vii) the rubber and other outer coverings of wires and cables are not allowed, either during construction or in service, to come in contact with dope, petrol, oil or similar preparations having a deleterious effect thereon ;

(viii) a non-corrosive type of flux is used for soldering cables, etc. (resin is recommended) ;

(ix) no possibility of danger to the safety of the structure of the aircraft will arise through acid leaking from battery cases ;

(x) the conductors of cables are free from strain where they are attached to terminals or other fittings ; and that the body of each cable is securely clamped at a point as near as possible to the terminal or fitting by means of a suitable clip ;

(xi) where an insulating separator is called for between any two metallic bodies, no process which tends to reduce the efficiency of the insulation is permitted.

Note.—The use of any metallic oxide paint, or metallic dope, is prohibited. The soaking of the insulator in paraffin wax or varnish is allowed.

6. Testing for operation.—(i) An accumulator of the requisite voltage is to be temporarily connected to the accumulator leads, and all switches, etc., operated several times to ensure that each circuit on the " battery branch " of the system is working satisfactorily and is unaffected by the working of any other circuit.

(ii) With the accumulator connected as for the preceding test, but with the plunger of the battery cut-out held up in contact temporarily by hand, and with generator leads disconnected at the generator end, a similar test is to be made for all circuits on the " generator branch " of the system.

Note.—" Generator branch " circuits should not be operative under the conditions of test (i), but under the conditions of test (ii) all circuits on both branches should be operative.

7. Inspection records.—On completion of inspection and testing, all necessary records shall be made and certified in the Civil Aircraft Inspection Record, A.M. Form 1221.

INSPECTION LEAFLET 21

INSPECTION OF COMPASS INSTALLATIONS IN AIRCRAFT

1. **General.**—The inspection of compass installations in aircraft will consist of :—

(i) a visual examination of the compass before installation to ensure good condition and correctness to type ;

(ii) a visual examination after installation to ensure freedom from damage during installation, compliance with drawing requirements as regards position, etc., absence of disturbing influences in the immediate neighbourhood of the compass, and freedom from tilt of the magnetic system of the compass (with the aircraft in normal position for level flight) ; and

(iii) supervision of the swinging of the aircraft for compass correction to ensure accuracy of the compass deviation card.

2. **Inspection before installation.**—Owing to the possibility of damage in transit or deterioration during storage, it is essential that every compass should be inspected immediately before installation in an aircraft. The inspector will assure himself on the following points :—

(i) freedom from pivot friction ;

Note.—The compass should be supported in a level position and the reading noted. A corrector magnet should then be brought close to the bowl and at right angles to the compass needles, thus deflecting the magnet system through about 5°. Remove the magnet and wait until the magnet system comes to rest. If it settles down exactly in its original position the compass is free from pivot friction. A compass may be considered satisfactory in this respect provided the amount of friction error is not more than can be eliminated by tapping the bowl with the finger, or by the vibration of the aircraft.

(ii) freedom from discolouration of the card, bowl, liquid or window ;

Note.—A compass can be considered satisfactory, if, under conditions of lighting which would normally exist during flight, the course can be read distinctly without undue difficulty.

(iii) good condition of anti-vibrational devices and all movable or working parts ; the bowl should be free from dents and if any exist it should be returned for repair ;

(iv) the bowl must be filled completely with the proper liquid.

Note.—The presence of even a small bubble in a compass bowl may set up " liquid swirl ", which may cause the magnetic system to swing, and the effect of this may be especially serious in aperiodic compasses. The newest patterns of compasses are all aperiodic. If bubbles are present the compass must be returned for reconditioning.

3. **Inspection of installation.**—In addition to the examination for compliance with installation drawings, specifications and schedules as to correct position and type of compass, the inspector must ensure that :—

(i) the compass has not been damaged by or during installation in an aircraft ;

(ii) no ferrous metal has been used in the compass support or platform, and only brass attaching screws have been used ;

(iii) no part of the aircraft comes in contact with the bowl of the compass ;

(iv) the compass is rigidly attached to the aircraft in such a way that the magnet system is in a normal untilted position when the aircraft is in normal flying attitude ;

(v) the vertical plane through the lubber line and the centre of the instrument is coincident with, or truly parallel to, the aircraft's plane of symmetry, with the lubber line forward ;

(*b*) Deviations on other bearings should be taken in a similar manner, by moving the aircraft slowly round the buoy with the aid of a dinghy or motor boat, and taking a large number of readings, which should be finally plotted to produce a deviation curve, which is used to complete the deviation card.

(*c*) When using a bearing plate in lieu of a bearing compass the plate should be fixed in the aircraft so that a line joining its lubber lines lies on or parallel to the fore and aft axis of the machine. The plate should be clamped with zero registering against the forward lubber line and readings taken from the foresight of the instrument. The process of taking readings is exactly similar to that when using a bearing compass but it must be remembered that with the bearing plate the angle measured is that between the distant object and the centre line of the machine, and to get the bearing this figure must be added to or subtracted from the compass reading, which is the angle between the magnetic meridian through the compass and the centre line of the machine. Any variation of this figure from the correct bearing as determined from the chart is the error of the compass on that particular bearing.

(ii) *By landing compass ashore.*—A landing compass is mounted ashore on a site free from local magnetic interference, and simultaneous bearings of the bearing compass or bearing plate in the machine from the landing compass and of the landing compass from the machine, are taken, simultaneous readings of the pilot's compass being taken also. To obtain good results it is essential that all observations should be taken at the same moment, for which purpose the services of at least three persons (preferably four) are required, *i.e.*, one at the landing compass ashore, one at the bearing compass or plate, one at the pilot's compass and, when possible, one on the aircraft to give the required signals. An additional observer will be required at each of the other compasses to be adjusted in the machine.

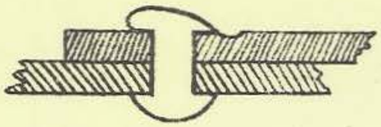
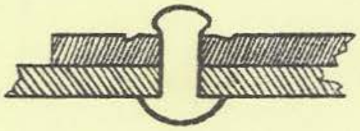
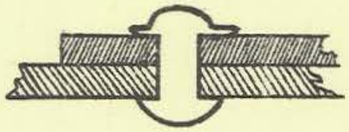
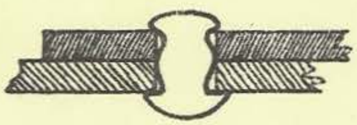
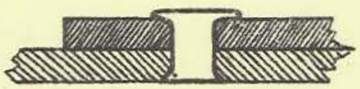
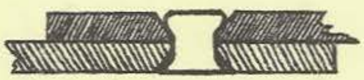
TABLE 1

(By landing compass ashore)

Course by Pilot's Compass (1)	Bearing by Bearing Plate (2)	Sum of Columns 1 and 2 (3)	Landing Compass Reciprocal (4)	Corresponding Magnetic Course (5)	Deviation (6)
268	48	316	322	274	+6
291	26	317	322	296	+5
318	2	320	323	321	+3
332	354	(686) 326	326	332	0
355	336	(691) 331	328	352	−3
20	308½	328½	325	16½	−3½
48	282	330	326	44	−4
83	249	332	327	78	−5
100	233	333	327	94	−6
139	189	328	325	136	−3
180	141	321	322	181	+1
205	113½	318½	321	207½	+2½
225	91	316	320	229	+4
258	60	318	324	264	+6

The sum of columns 1 and 2 gives the equivalent of the bearing of the landing compass from the pilot's compass in the aircraft. Column 6 shows the deviation for the courses by compass in column 1. The magnetic courses corresponding to these compass courses are given in column 5. From this information a deviation curve is plotted, and entries on the deviation card are made from this.

5. Analysis of deviations.—All the possible disturbing magnetic influences in an aircraft on the compass can be resolved into five distinct classes, which are known as co-efficients, and are distinguished by the five capital letters A to E. It should be particularly noted that deviation figures are always preceded by an algebraic sign, the significance of which is extremely important. When it is necessary to increase the compass reading to obtain the correct magnetic reading the deviation is preceded by a positive sign. Similarly, when it is necessary to reduce the compass reading to obtain the correct magnetic reading the deviation is preceded by a negative sign (*e.g.*, if the compass reading is 94° when the correct magnetic reading is 90°, then the deviation is −4°).

1		*Snap not struck normal to surface of plate – Damage to plate and weak head.*
2		*Rivet too short – Snap cutting into plate, weak head.*
3		*Rivet too long – damage to rivet & plate, excessive number of blows.*
4		*Hole too large – Weak head and leakage.*
5		*Countersink too shallow. Weak Joint, and not flush unless filed.*
6		*Countersink too deep – Plates not held up, and leakage.*

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Figs 1-6 (Inspection Leaflet 24)

INSPECTION LEAFLET 1

INSPECTION OF AIRCRAFT

General

1. The value of the inspection of an aircraft depends :—

(i) upon the skill and care with which each inspection operation is performed ; and

(ii) upon every detail and assembly being systematically followed through from the raw material to the finished product.

All operations are of equal importance. An aircraft can, therefore, be certified for airworthiness only when the inspector is fully satisfied that each operation in the complete series has been performed efficiently.

2. The importance of 1 (i) above makes it necessary that delegated operations should be controlled, not only by establishing that the persons to whom they have been delegated are qualified to do the work involved, but also by periodical check inspections.

3. The accompanying chart (fig. 1) shows the sequence of the operations necessary in the case of an aircraft of orthodox design. It is, however, recognised that variations in the circumstances in which aircraft are built may make it desirable that the usual procedure should sometimes be departed from in certain respects ; every proposed departure must be sanctioned by the supervising inspector. Permission to depart from the usual procedure should always be applied for in cases where that procedure is likely to be cumbersome, ineffective or otherwise unsuitable.

4. In the case of Type aircraft, all operations shown on the chart within a broken line border will be the responsibility of the maker, whilst those shown within full line borders will be performed by A.I.D. staff. Certain inspection operations which, in the case of a Type aircraft, have to be done by both the maker and A.I.D. staff are shown within a double border formed of both broken and full lines. In the case of Subsequent aircraft all operations, whether shown in broken or full line borders, will be the responsibility of the maker.

5. The satisfactory completion of all operations must be indicated by (i) inspection stamps on the parts or components or (ii) entries on labels or in record books or (iii) certificates in the Civil Aircraft Inspection Record (A.M. Form 1221).

6. It is essential that the person responsible for each operation shall be traceable and that the record of his approval shall take the form required by the chart.

7. The various forms of record are indicated on the chart by the following abbreviations :—

R.N.	indicates a release note.
S.	indicates a stamp on the part or component.
L.	indicates an entry on the inspection process label.
B.R.	indicates an entry in a record book.
I.R.	indicates a certificate in the Civil Aircraft Inspection Record.

8. The inspector responsible for certifying in A.M. Form 1221 (on the page headed " Record of Installation ") the correctness of assembly of flying controls must not be the same person as the ground engineer licensed in Category A who gives the " Certificate of Final Inspection for fitness for Flight."

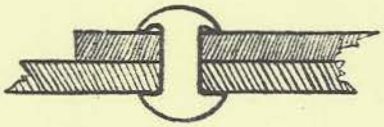
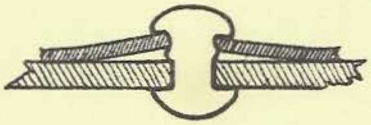
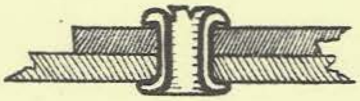
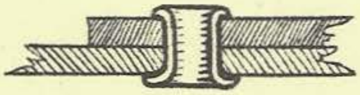
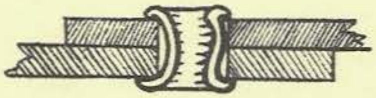
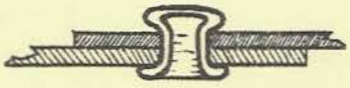
9. The various components comprising the aircraft, together with their identification marks and inspection stamp numbers, are to be noted, and the certificates for the various installation inspection operations are to be completed, in the Civil Aircraft Inspection Record.

10. The certificate on the front page of the Civil Aircraft Inspection Record that covers final inspection of the completed aircraft shall be completed only when :—

(i) all the operations comprising the inspection of the "Complete aircraft," as shown in the chart, have been performed ;

(ii) the aircraft has been tested in flight ; and

(iii) a certificate of safety for flight has thereafter been completed.

7		Spun head, or unsuitable snap tool. Head touching work on rim line only.
8		Plates not held tightly. Deformed shank and Weak Joint.
9		No radius on plates & burrs causing bad closing and cracks.
10		Rivet too short — Weak Head.
11		Hole too large — Crippled Rivet, Weak Joint.
12		Operating tool too long, preventing Rivet closing on thin plates.

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Figs 7-12 (Inspection Leaflet 24)

INSPECTION LEAFLET 27

INSPECTION OF RADIATORS FOR LIQUID-COOLED ENGINES

1. General.—This leaflet, together with others relative to the inspection of parts and control of processes employed in the construction of radiators for liquid-cooled engines, is to form the basis for the inspection of radiators. Having established that all materials employed for construction have been previously approved and that all detail parts and assemblies have been inspected and found to be fully in accordance with the requirements of approved drawings and design requirements, the inspector will proceed with the inspection of the radiator during construction and test in the following manner.

2. Manufacture.—The inspector is to verify that :—

(i) the temperature of the solder dipping bath is adequately controlled and maintained ;

Note.—A rise in melting point will indicate deterioration or contamination of the bath, the tin content of which should not be allowed to fall below 45 per cent.

(ii) all surfaces in contact at joints are tinned before soldering ;

(iii) where the corner joints of a tank take the form of superimposed angles, sweating is effected from both edges forming the joint ;

(iv) every trace of flux is removed from all parts, including the tube block, by washing with hot water or other approved process, and that this cleaning has been done as soon as practicable after the soldering or dipping operations.

3. Process inspection.—The inspector is to verify that :—

(i) the casing with all its constituent parts conforms to drawing requirements in regard to dimensional accuracy and the correctness of location of all stiffeners, baffles and other internal parts which become concealed on fitting the tube block ;

(ii) the tubes have been correctly assembled as a block and the specified width of water-way has been maintained throughout the block ;

(iii) the block has been dipped to a uniform depth of not less than 3 m.m. or more than 4 m.m. ;

(iv) the weight of solder picked up during the dipping process has been determined, recorded and checked to establish that no abnormality has occurred ;

(v) the casing fits snugly to the tube block and no excessive loading has been resorted to.

Note.—At this stage the inspector will have verified and recorded by stamp the correctness of all processes prior to the radiator being cleared for final inspection and test. *See* sub-para. 8 (iii).

4. Capacity and weight determination.—The inspector is to verify that :—

(i) the first radiator constructed to a new design (or modified design if the modification affects capacity) is tested for compliance with the specified capacity ;

(ii) a percentage (not less than 2 per cent.) of subsequent radiators is tested for capacity ;

(iii) the dry weight of each new radiator is determined and recorded.

INSPECTION LEAFLET 28

INSPECTION OF THE INSTALLATION OF ENGINE CONTROLS

1. General.—The routine for the inspection of the controls should be such that the inspector is able to satisfy himself of their correctness as regards manufacture, installation and functioning. To this end particular attention is to be given to the following :—

2. Detail parts.—The inspector is to verify that the requisite evidence of prior inspection and approval is available in respect of all materials and detail parts employed in the construction of the control system.

Note.—Normally, the controls are approved for design as part of the complete aircraft, not separately. When controls of proprietary design are installed, the inspector is to verify that their design has received prior approval.

3. Installation.—(i) *General.*—The inspector is to verify that :—

(*a*) each control system as installed is correct to drawing ;

(*b*) all joints and pins are effectively locked ;

(*c*) the run of control cables, pipe lines, etc., is such that there is no likelihood of their being damaged or affected by normal movements of the occupants or equipment of the aircraft.

(ii) *Mechanically operated controls.*—The inspector is to verify that :—

(*a*) inspection of made-up cables and chains has been made in accordance with the appropriate Inspection Leaflets ;

(*b*) the lead of any cable passing over a pulley is in line with the pulley groove ;

(*c*) the alignment of rods, bell cranks, levers, chains, etc., is correct ;

(*d*) long lengths of cable between pulleys are suitably supported.

(iii) *Hydraulically operated controls.*—The inspector is to verify that :—

(*a*) the individual runs of hydraulic piping are correct to drawing ;

(*b*) the joints have been correctly assembled ;

(*c*) all joints, cocks, etc., have been proved free from leakage by the application of a suitable pressure test.

(iv) *Ignition switches and wiring.*—The inspector is to verify that :—

(*a*) the ignition switches are of an approved type and correctly installed ;

(*b*) electric cables of the correct type and size have been used in the ignition circuits, and the requisite electrical tests for continuity and insulation have been satisfactorily completed.

4. Operation of controls.—Each control is to be inspected during operation to verify that :—

(i) the direction of movement and range of travel are correct both at the operating and operated ends ;

(ii) free and regular movement is obtained throughout the specified travel without undue backlash ;

(iii) no fouling of adjacent parts or structure occurs with the controls in any position ;

Inspection Leaflet 31
This sheet re-issued May, 1938,
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INSPECTION LEAFLET 31*

INSPECTION OF AIRCRAFT METAL FITTINGS AND PARTS MADE FROM SHEET OR STRIP MATERIAL

1. **General.**—Aircraft metal fittings and parts made from sheet or strip material must be inspected to verify that they comply with the relevant drawings in all respects and that the standards of workmanship and finish are satisfactory. Specific requirements are given below.

2. **Identification of material.**—The inspector must verify that :—

(i) the fittings or parts have been made of the materials specified in the drawings ;

(ii) the correlation of the materials with the corresponding release notes is maintained throughout the course of manufacture.

3. **Processes.**—The inspector must verify that :—

(i) heat treatment processes have been correctly applied and that the necessary control tests have been made in accordance with the relevant specifications and/or Inspection Leaflets 407 and 414 ;

(ii) welding operations have been performed in accordance with Inspection Leaflet 39.

4. **Dimensions.**—The inspector must verify that :—

(i) all dimensions (including the pitch centres and diameters of holes) are within the permitted tolerances ;

(ii) the thickness of the material agrees with the gauge specified, this being particularly important for any part that has been heat-treated ;

(iii) standard patterns, where provided, are not departed from, notwithstanding that the drawings may differ from the standard.

5. **Workmanship.**—The inspector must verify that :—

(i) all sharp corners and surface roughnesses have been removed by grinding, filing or other suitable methods (it is particularly important that this should have been done in the vicinity of bends prior to the bending operations) ;

(ii) there is no evidence of any tendency to crack either at the bends or any edges adjacent to bends ;

(iii) when punching, drilling, paring or machining operations have been performed on steel strip in the hardened condition, all cut edges have been smoothed over by grinding or draw-filing along and not across the edges and that all rags or burrs have been removed.

6. **Protective treatment.**—The inspector must verify that the protective treatments specified on the drawings have been applied in accordance with the relevant specifications and inspection leaflets.

7. **Identification markings.**—The inspector must verify that the identification markings are legible and in the correct positions, as indicated on the drawings. He must bear in mind that heavily stamped markings and markings close to any edge, bend or hole or across any narrow or highly stressed part, are likely to cause fatigue.

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* This revised leaflet will take effect as from 1st May, 1938. (704916/37

INSPECTION LEAFLET 37

INSPECTION OF FUEL, LUBRICATION AND COOLING SYSTEM ACCESSORIES

1. General.—The correct functioning of the fuel, lubrication and cooling systems of an aircraft being entirely dependent on the satisfactory functioning of *all* their component parts, it is essential that all cocks, valves, filters and other accessories should be separately inspected prior to their installation.

2. Materials and details.—The inspector must ensure that all materials and fittings used in the construction of each accessory are fully in accordance with drawings and appropriate specifications. All separate details must bear evidence of a prior authorised inspection in the form of inspection stamps.

3. Testing.—In addition to any necessary tests of its detail parts, each completed accessory must be subjected to the pressure, flow and/or delivery tests called for on the drawing or specification. A careful examination must also be made to ensure the entire absence of solder, grit or other foreign matter likely to cause leaks, obstruction of the flow, or faulty working of the accessory.

4. Tests.—(i) When other tests have not been specified, the following are to be made.

(ii) *Petrol cocks and valves.*—(*a*) *Pressure test.*—Petrol cocks and valves must withstand an internal pressure of 15 lb. per square in. without leaking. This test may be made using paraffin internally (the castings being whitened externally) or by means of internal air pressure with the cock or valve wholly immersed in petrol or paraffin. Special tests may be required in the case of particular cocks which are either proprietary articles or are subjected in service to considerable heads of petrol as in the case of those for airships.

(*b*) *Flow test.*—Under a standard head of 1 ft. each cock or valve, when open, must pass petrol at not less than the minimum rate in gallons per hour called for on the drawings or specification. (The test must not be made with a liquid other than petrol.)

(iii) *Drain cocks.*—Each drain cock (with a film of oil between the plug and the body) must withstand a test pressure of 15 lb. per sq. in. without leakage.

(iv) *Petrol pumps.*—Each petrol pump must be tested at a pressure of 15 lb. per square inch to ensure the soundness of its body, and in all cases a capacity delivery test must be made under approved conditions as regards speed and suction and delivery heads.

(v) *Rotherham air pump.*—Each pump must have its outlet connected to a closed container of 5 gallons capacity (a standard 5-gallon drum being suitable). When run at a propeller shaft speed of 1,450 revolutions per minute it must raise the pressure in the container from 0 to 6 lb. per square in. in not more than 80 seconds with the relief valve fully closed, and in not more than 5 minutes with the relief valve set to open at 6 lb. per sq. in.

(vi) *Vickers, Mark III, hand petrol pumps.*—Each pump must be tested by hand operation, using petrol, and must deliver at a rate not less than 140 gallons per hour under a suction lift of 3 ft. and a delivery head of 3 ft., at a speed of not more than 100 strokes per minute.

(vii) *Vickers centrifugal petrol pumps.*—Each completed pump must undergo a running-in test on the bench against a pre-arranged head, followed by a delivery test under the conditions of ~~section~~ SUCTION and lift stated below. After the tests the soundness of the glands and joints must be tested by means of a further pressure test, and in addition care must be exercised to ensure that

INSPECTION LEAFLET 39

WELDING OF AIRFRAME PARTS

1. General.—(i) Airframe parts may be welded only if they are approved as being of a design for which welding is suitable. The welding must be done under approved conditions, and the inspector is responsible for seeing that these conditions are maintained.

(ii) Welded joints will normally be permitted only in positions where failure of any one welded joint will not involve the collapse of the structure or cause the pilot to lose control of the aeroplane (*vide* Design Leaflet B.5, sub-para. 10 (ii)). Subject to the concurrence of the Air Ministry this requirement may be waived in the case of certain repairs to damaged members, when the nature of the repairs provides a considerable margin above the strength of the original undamaged member. Special consideration will also be given to cases in which the area of the weld is large in relation to the load to be carried and the form of the joint will ensure a good weld.

2. Approved conditions.—Since the inspection of a finished weld is mainly confined to a visual examination, the inspector has to rely upon the maintenance of the approved conditions, which include the following :—

(i) the use of approved materials ;

(ii) the approval, and maintenance, of the standard of efficiency of the welders ;

(iii) the use of approved methods.

3. Materials.—(i) The inspector must verify that the materials to be welded are approved for such process.

(ii) All parts made of ferrous material must be heat treated after welding, except (*a*) when the drawing is endorsed to the effect that heat treatment may be omitted, or (*b*) in the special instances referred to in the Note below. When the design permits of heat treatment after welding, any of the aircraft steels which conform to B.S. or D.T.D. Specifications may be used, subject to the approval of the Air Ministry.

Note.—Local application of heat, such as flame normalising, is not permitted for heat treatment purposes. Parts made from non-corrodible steels to D.T.D. Specifications Nos. 171, 176 and 207 may be used in the "as welded" condition. Edge and spot welding are permitted on non-corrodible steel to D.T.D. Specification No. 166 without subsequent heat treatment, but it should be noted that the strength of this steel in the vicinity of the weld will be reduced to that of steel to D.T.D. Specification No. 171.

(iii) All steels other than those of the non-corrodible kind must be welded with iron or mild steel wire to D.T.D. Specification No. 82, or with a rod or strip of approximately the same composition as the material being welded.

(iv) Non-corrodible steels must be welded with rods or strips of approximately the same composition as the material being welded or with rods to D.T.D. Specification No. 61.

(v) The heat treatment referred to in sub-para. (ii) must be that which is defined in the relevant materials specification. Details in regard to the correct temperatures should be obtained from the relevant release notes.

4. Personnel.—The inspector must verify that all persons engaged in the welding of airframe parts (except unimportant parts, *i.e.*, parts which have not been stressed when considering design) have been proved competent to perform this operation ; the proof shall take the form of a satisfactory report by the A.I.D. Test House No. 2, Cardington, upon standard test specimens prepared by each welder. For further instructions, *see* Appendix A.

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INSPECTION LEAFLET 34

INSPECTION OF SPLICES IN AIRCRAFT CABLES

1. General.—(i) Spliced joints in cables used in the control systems or structure of an aircraft play so important a part in the operation and strength of the aircraft that such inspection measures as will ensure the optimum efficiency being obtained are essential.

(ii) The splices must be of the type shown in figs. 1 and 2 of this leaflet, and the splicing process and finished splice should be inspected as indicated below.

2. Inspection of splicing process.—(i) With the object of ensuring that the finished splice will meet design requirements, the inspector is to make periodic checks of each of the operations and must verify that the necessary precautions are being observed during progress.

(ii) The check should establish that :—

(*a*) when lengths are cut from reels of cable the necessary precautions are taken to prevent the cable from becoming un-layed on either side of the cut ;

(*b*) the cable is snugly fitted round and tightly secured to the thimble at two or three points, and is served with waxed string for a sufficient distance on both sides of the apex of the thimble before tucking is commenced ;

(*c*) individual strands are tucked in the manner shown in fig. 1 ;

(*d*) the correct number of tucks is used and the ends finished off in the manner described ;

(*e*) the splice is hammered taut ;

Note.—A hardwood mallet or raw-hide hammer and a hardwood anvil should be used for the purpose. The splice should be rotated during the process of hammering so that all strands will be equally tautened.

(*f*) after the hammering process the loose ends are cut off and the splice finished by serving with waxed thread.

3. Inspection of finished splice.—(i) It will be appreciated that the tautness of the finished splice will depend on the manner in which it is made, and if reasonable care is exercised in the various operations a satisfactory splice will be assured.

(ii) If, therefore, the inspector has satisfied himself that the various operations have been performed satisfactorily, it will only be necessary, when he inspects the finished splice, to verify that :—

(*a*) the splice is symmetrical and good in appearance, and the strands and wires lie close together ;

Note.—No light should show between the wires when the splice is held to the light.

(*b*) the splice is resistant to bending and when bent the wires and strands remain close and tight ;

Note.—A bad splice will not resist bending and when bent the strands and wires become slack although, to all outward appearance, the splice may appear a good one.

(*c*) the thimble is quite tight in the loop ;

(*d*) the "lay" of the cable has been maintained so far as the splice permits ;

(*e*) the serving is even and tight and the ends properly secured ;

(*f*) each cable is stretched by the application of a load equal to 50 per cent. of its specified breaking load.

* *Note.*—The efficiency of splicing should be checked by occasional tests to destruction. A correctly-made splice in flexible steel cable should have a strength of not less than 80 per cent. of the ultimate strength of unspliced cable.

4. Inspection marking.—Inspection marks should be applied in accordance with the requirements of Inspection Leaflet 18.

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* To take effect as from 1st May, 1938. (67S302/37.)

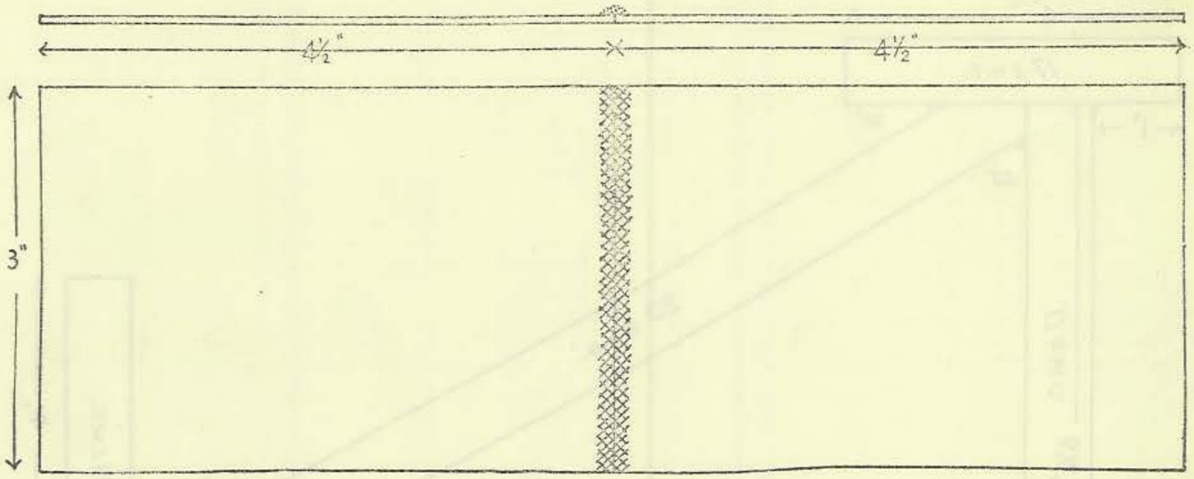
(vi) If any specimen submitted for test is found to be unsatisfactory, the welder concerned should be allowed to submit a fresh set, provided that he or she has had an opportunity of acquiring additional experience on the welding of unimportant parts (*see* para. 4 of the leaflet) in the meantime.

(vii) As regards persons who had been employed as welders for a considerable period prior to the issue of this leaflet, and of whose skill there is no doubt, the firm's approved inspector will refer to the supervising inspector, who may use his discretion as to whether such persons must submit specimens of their work for test and, if he considers this to be unnecessary, shall record his approval of each welder concerned, and notify the Inspector-in-charge, A.I.D. Test House.

(viii) Each welder's work should be checked once every six months by testing samples of work done in the ordinary course of events. If the operator whose work is to be checked is engaged on parts that are too costly to be taken for test, it may be possible to arrange that he shall work on other parts, of which a sample can be taken.

(ix) A check test should also be made whenever a welder is required to work on a material other than that to which he has been accustomed over a lengthy period.

(x) Records of approved welders at civil aircraft firms will be maintained at the A.I.D. Test House No. 2, Cardington, and by the supervising inspector.



Sheet to Sheet Butt Weld. 16 S.W.G.

FIG. 1. (Inspection Leaflet 39.)

INSPECTION LEAFLET 41

INSPECTION OF PLYWOOD

1. British-made plywood.—(i) Inspection of British-made plywood for use in structurally important parts shall consist of a detailed process inspection to verify that :—

(*a*) both outer and inner veneers are of the specified timber, that they comply with specification requirements in regard to quality, grain, thickness, freedom from dote and other timber defects, and that they are properly matched for joining and assembling ;

(*b*) the cement is applied to the veneers uniformly and over the entire area of the surfaces in contact ;

(*c*) records are maintained showing the press gauge readings and the time the boards are kept in the press ;

(*d*) each board is stamped with its batch number immediately it is taken from the press ;

(*e*) the ventilation, temperature and humidity are maintained during the drying or conditioning operation ;

(*f*) the edges of each board are trimmed square.

(ii) Tests of representative samples of plywood for important parts are to be made at an approved test house to check compliance with specification requirements (for size of samples, *see* Appendix).

Note.—Boards which have been made from one mixing of cement are considered to comprise one batch ; and provided the temperature, pressure, and time of pressing are proved to have been uniformly maintained throughout the manufacture of the batch, two samples cut from boards made at the beginning and end of the batch may be considered sufficiently representative. Should any of the above conditions not have been maintained throughout manufacture, further samples may be required at the inspector's discretion.

(iii) An inspection is to be made of each finished board to ensure correct dimensions, and compliance with specified requirements as regards joins, flatness, and freedom from manufacturing defects such as blisters, shakes, gaps, overlapping joins and wrinkles. Each board approved shall bear the inspector's stamp, the names of the timbers used for the veneers, and the date of manufacture.

(iv) The inspection of British-made plywood for use in subsidiary parts shall consist of a visual examination of each finished board to verify that :—

(*a*) the plies are securely cemented together ;

(*b*) the plywood is flat and free from buckling, blisters, wrinkles, gaps, overlaps and other defects, and the joins in the plies comply with the specification ;

(*c*) the edges of the boards have been trimmed square and the surfaces are free from defects.

(v) Tests of representative samples of plywood for subsidiary parts shall be made at an approved test house to check compliance with specification requirements.

2. Imported plywood.—(i) When no evidence of detailed process inspection or system of batching is available, the inspection of imported plywood for use in structurally important parts of civil aircraft shall consist of :—

(*a*) an examination of the inner plies to verify freedom from timber defects and the absence of gaps or overlapping joins, etc. ;

INSPECTION LEAFLET 43

INSPECTION OF METAL SEAPLANE HULLS AND FLOATS

1. General.—(i) It is of primary importance that metal hulls and floats be inspected in progressive stages during construction to ensure that both materials and workmanship are of the required standard.

(ii) In making this inspection it is desirable that a standard sequence of main and intermediate stages should be followed, deviation from this being permitted only when necessary to provide for special features of design, or to suit arrangements in force at works.

(iii) The inspection stages should be tabulated on a card or chart which is to be attached to the hull or float during construction, and at the completion of each stage the inspector must impress his stamp in the space provided.

(iv) The inspection procedure referred to hereunder is applicable to both hulls and floats, except where otherwise indicated.

(v) All materials, fittings and details used in the construction must fully conform to the requirements of the relevant drawings and specifications.

(vi) Part numbering and inspection marking as requisite is to be done in an approved manner.

(vii) It is of extreme importance that watertightness be obtained, as little dependence as possible being placed on the paint or jointing medium used. To this end, all joints, riveted or otherwise, must be closely scrutinised.

2. Protective treatment.—(i) The process and method of application of protective treatment must be approved and the quality of the finish verified by the normal tests.

(ii) When this treatment is applied to details prior to final assembly (as will be necessary in many instances), great care will be required in subsequent handling to ensure that no damage is done to the treated surfaces.

3. Process inspection.—(i) When the construction of a hull or float is commenced it is to be allotted a serial number. This number should be recorded on an inspection chart or label, a typical form of which is shown at Appendix I. Examples of hull and float process inspection cards are furnished in Appendices II and III respectively and a short glossary of technical terms used in connection with hull and float construction is given in Appendix IV.

(ii) Before any assembly work is commenced the inspector must verify that all details bear evidence of prior inspection.

(iii) Main and intermediate inspection stages are described hereunder, and whilst the sequence may be varied as already stated, the inspector must ensure that each stage is dealt with at the proper time and the appropriate column of the inspection chart and/or label stamped as each stage is completed.

4. Lay off of lines.—(i) Lines and body sections are to be checked on the mould loft floor and scrieve boards. This operation is to be performed as soon as the construction of each new type of hull or float is begun.

Note.—The lines are laid out from a table of " off sets " and it is customary to correct any lack of truth at this stage. If any alteration is found necessary, it is of importance that the body sections be corrected at the same time.

APPENDIX II

SEAPLANE HULL PROCESS INSPECTION CARD

Type of hull.................................. Ctt. No.............. Serial No............

No.	Process stage	Inspector's stamp	Date	Remarks
1	Lines and body sections checked on floor and scrieve boards.			
2	Frames checked to scrieve boards or templates.			
3	Keel and keelson checked to profile ..			
4	Stocks, profile and moulds erected ..			
5	Keel, keelson, stem and sternpost erected on stocks and checked for alignment and position.			
6	Frames checked in position on stocks..			
7	Dorsal and coamings checked to profile or template.			
8	Dorsal and coamings checked on stocks			
9	Complete framework of hull ready for plating.			
10	Datum blocks, position and level ..			
11	Shell plating complete			
12	External fittings :— (*a*) Main plane .. } Attachment points. (*b*) Centre section .. (*c*) Tail plane .. (*d*) Rudder .. .. (*e*) Engine nacelle .. (*f*) Towing eyes ..			
13	Water test			
14	Internal fittings :— (*a*) Electrical .. .. (*b*) Wireless .. .. (*c*) Fuel .. .. (*d*) Water .. .. (*e*) Controls (aircraft) .. .. (*f*) Anchor and fittings .. .. (*g*) Hoisting gear .. .. .. (*h*) Other fittings			
15	Final inspection of completed hull ..			

INSPECTION LEAFLET 51

INSPECTION OF AIRCRAFT LINEN FABRIC

1. The inspector of aeroplane fabric must ensure that every requirement of the relevant specification has been complied with. The specification states definite requirements as regards :—

(i) quality and manufacture ;
(ii) size-softening agents ;
(iii) ends and picks ;
(iv) width ;
(v) weight ;
(vi) strength.

2. The inspection necessary to ensure that each of these requirements has been complied with is as follows :—

Para. 1 (i).—A visual examination should be made of the finished material for weaving defects when all manufacturing operations have been completed. The examination consists of passing the fabric yard by yard over " light " rails or an artificial light table. Selective inspection is not permitted. The defects listed below (*see* attached illustrations) must be marked by means of a red thread sewn in the selvedge opposite the fault, and all webs or pieces found to contain more than six such faults are not to be passed for aircraft material. The marked faults must be cut out prior to the use of the fabric for covering aircraft components.

(i) Weft snarl.
(ii) Float.
(iii) Thin place.
(iv) Two ends out.
(v) Bad weft slub.
(vi) Bad warp slub.
(vii) Catch.
(viii) Catch and single end out.
(ix) Weft float.
(x) Rip out or unweaving place.

Minor faults, such as those in the following list, need not be marked during visual examination and may appear in aircraft fabric coverings.

(i) Single end out.
(ii) Small catch.
(iii) Small slub.
(iv) End loose.
(v) Beetle crease.
(vi) Small snarl.

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405.	Inspection of Soldering and Brazing.
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414.	Heat Treatment of High Tensile Wrought Aluminium Alloys.
416.	The Hounsfield Tensometer.
417.	Determination of Proof Stress.
421.	Doping.
426.	Control of Heat Treatment of Duralumin Rivets.
430.	Classification of Steels.
432.	Inspection of Flexible Steel Wire Rope.
435.	Gluing of Structurally Important Parts of Aircraft.

INSPECTION LEAFLET 124

DEFINITION OF THE WEIGHT OF AN AERO ENGINE

1. When determining the weight of an engine, all parts and accessories necessary to enable the engine to run satisfactorily should be taken into account. Definitions of engine weight are given below :—

(i) The *nett dry weight* includes the weight of all appropriate items amongst the following : ignition system, bonding and screening, carburettors and induction systems, engine-driven fuel pump, water outlet collector pipes, control rods interconnecting carburettors or magnetos, starting gear and accessory drives incorporated in the engine, supercharger system complete. It excludes the weight of the airscrew hub, exhaust branch pipes, manifolds and stub pipes, pipes connecting the water outlet collector and water pump to the radiator, air-intakes, oil and water.

(ii) The *gross dry weight* exceeds the net dry weight by the weight of the airscrew hub complete ; exhaust branch pipes, manifolds and stub pipes ; air-intakes ; starting units fitted to the engine ; claws ; primers, accessories and controls ; engine oil and petrol filters and relief valve for engine-driven fuel pumps. It excludes the weight of the radiator, coolant and interconnecting pipes ; tanks, fuel, oil, exhaust tail pipes and engine instruments.

(iii) The *weight in running order* exceeds the gross dry weight by the weight of the radiator and coolant ; all inter-connecting pipes and controls ; and oil on internal parts (in a normal oily condition). It excludes the weight of tanks, fuel, oil, reserve coolant exhaust tail pipes and engine instruments.

2. Particulars of the nett dry weight and gross dry weight must be given in all Type test reports and are to be supplemented by an appendix containing a detailed analysis, in accordance with the foregoing definitions, of the difference between the two, and of items to be included in the weight in running order (such as the allowance to be made for oil on internal parts). In the case of liquid-cooled engines, the radiator capacity must also be reported.

3. The approved nett dry weight of an engine will be that which is stated in the Type technical certificate. The nett dry weight of each Subsequent engine should be checked, and if it differs from the approved figure by more than 2½ per cent. the cause of the discrepancy should be investigated and, if possible, eliminated, failing which, the facts must be reported to The Secretary, Air Ministry (R.D.E.2), in order that the Type technical certificate may be amended. Every change in weight caused by the incorporation of a modification must be noted, and as soon as the total change exceeds the limit specified above it must be reported. The nett dry weight is to be quoted in the record of inspection during manufacture.

4. Either the nett dry weight or the gross, clearly described as such, is to be stated in the standard log sheet (inspection and test certificate) referred to in Design Leaflet C.2, para. 4.

INSPECTION LEAFLET 128

INSPECTION APPROVAL MARKS ON ENGINE AND ENGINE ACCESSORY PARTS

1. The application of numbers or other marks to aero engine or engine accessory parts may cause concentration of stress and enhance the risk of failure from fatigue. All marking, whether for the identification of material, design, manufacturing process or inspection, or for other purposes, must therefore be done with due care and under effective supervision.

2. The usual types of marking are :—

(i) depressions made with hard steel stamps ;

(ii) shallow depressions made by acid etching or electric engraving ;

(iii) raised (or, occasionally, depressed) markings caused by corresponding marks in the mould or die used when shaping the material.

3. On stressed parts the position and type of marking are important, and should be indicated on the approved drawing of each such part. When this information has been omitted, the inspector must discuss the matter with the engine designer, establish with him a definite location for all marks used, and verify that the necessary particulars are in due course added to the approved drawings. It is usually undesirable to locate marks where (or near where) a change in section or pronounced change in surface contour occurs. Part numbers and final inspection marks should be close together, wherever possible, since this facilitates checking.

4. The size and depth of the impression and the form of the stamp used for the marking referred to at (i) of para. 2 are important. The inspector must, therefore, verify by frequent examination that the marking is correctly positioned and legible (but not unnecessarily deep or large), and that the form of the stamp is such that fatigue cracks are not induced. When inspection stamps comprise a series of letters or figures or a trade mark or other device, the markings should be surrounded by a continuous line, devoid of angles or sudden changes in direction.

5. It is often preferable that the necessary marks on highly stressed parts and hardened parts should be etched or electrically engraved, in which connection the following points should be observed :—

(i) In the case of acid etching, action must be taken to ensure that all traces of corrosive substance are entirely removed after the etching operation, and to prevent spread of corrosion.

(ii) Before an electric engraving process is approved, the extent and degree of deterioration of the metal surrounding the engraved marks must be determined. Electric engraving by the constant contact process may cause deterioration of the metal below the surface of the marking and has much more effect than is ordinarily perceptible by visual examination. Electric engraving devices of the intermittent contact type usually have no adverse affect on the metal surrounding the marking.

6. When marks are formed in the material during the stamping or pressing, and especially if a part has been inadvertently reversed in the die and struck on both sides, the grain of the material in the neighbourhood of the marking will be distorted, and may lead to weakness in the finished part. The formation of markings during stamping or pressing should, therefore, receive close consideration before this method of marking is adopted.

7. It is frequently found necessary or desirable to supplement the batch identification called for in material specifications by providing the more important parts, such as master connecting rods, crankcases and cylinder heads, with serial numbers, which should be arranged so that they will easily be recognisable and not confused with other marks.

8. The serial numbers of V and vertical engines should be stamped on the forward end of the top half of the crankcase and those of radial engines on the front of the main portion of the crankcase. The serial numbers should also be shown on the data plates affixed to the engines.

9. Whenever possible, the identification marks for accessories should be on the outside of the main casing, and in a position where they will be clearly visible when the accessories are installed in an aircraft.

INSPECTION LEAFLET 132

TIGHTENING OF NUTS, LOCKNUTS, ETC.

1. Investigations into the failures of various parts of airframes, engines and accessories have shown them to be due in some cases to the under- or over-tightening of threaded parts. Over-tightening causes distortion, such as stretching or buckling, while under-tightening may induce pulsating loads and vibration. Damage has also been found to occur as a result of using ill-fitting tools.

2. The tension applied during the tightening-up of threaded parts, such as studs and bolts, cannot normally be determined by subsequent inspection, and control of this operation must therefore consist of a general supervision to ensure that the correct tools are provided and used, this being supplemented by occasional trials on the tightness of the more important parts.

3. Inspectors should therefore take special care to ensure that the tools used for assembling parts and components will permit, in normal use, of the correct tension being applied, and are in such condition that locating faces will not be damaged. It is also necessary to ensure that the loading applied is not improperly augmented by using tubes to increase effective leverage or by hammering on the end of a spanner.

Note.—When the spanner or other tool is designed to limit the maximum torque applied (as with a spring-loaded or slipping clutch spanner), arrangements must be made to check its functioning, the intervals between such checks being determined as a result of experience.

4. Except when spanners of special design are required, the spanner lengths corresponding to the various sizes of studs or bolts can be ascertained by reference to B.S. Specification No. 192/1924 (British Standard Spanners), with Addenda dated May, 1927, but it is to be noted that the use of the small end of a double-ended standard spanner may provide an effective leverage greater than is obtained with a single-ended spanner of the same nominal size. An abridged table of spanner lengths, compiled from the above-mentioned specification, is given below for reference.

Diameter of bolt.	Length of single-end spanner	
	B.S.W.	B.S.F.
in.	in.	in.
$\frac{1}{4}$	5	$3\frac{1}{2}$
$\frac{3}{8}$	6	5
$\frac{1}{2}$	8	6
$\frac{5}{8}$	9	8
$\frac{3}{4}$	10	9
1	15	12

5. When tightening-up parts or nuts against fairly easily compressible washers or packings, the loading applied should not be such as will cause excessive distortion or risk of the assembly becoming unsafe.

6. The use of excessively long tube or box spanners, by which bending loads may be imposed, should be avoided where possible.

INSPECTION LEAFLET 138

INSPECTION OF WHITE METALLING OF AERO ENGINE BEARINGS

1. General.—The white metalling of connecting rod big end, crankshaft journal and similar bearings is a highly important process, since the reliability of an engine is largely dependent upon the efficiency with which it is done. It should therefore be undertaken only when adequate facilities exist. The specifications for white metals usually include a stipulation to the effect that the brand of metal used shall have been proved to be satisfactory during the engine type test : it is therefore essential that metal to the correct specification and brand is used when making new bearings or re-metalling old bearings. The other points on which the success of the process largely depends are :—

(i) the use of virgin white metal only ;

(ii) scrupulous cleanliness ;

(iii) strict control of all temperatures ;

(iv) close attention to detail throughout.

In addition to the necessity of using only the approved brand of white metal for a particular bearing, engine constructors often find special methods of producing the bearings to be necessary. Such methods must be closely supervised in order that the physical and other characteristics may be maintained. While it is not within the scope of this instruction to give complete details of specific white metalling processes, the following notes are intended as a guide on the more important points of inspection.

2. Cleaning.—The cleaning of a shell or housing in order to remove all traces of oil and grease prior to "tinning" is usually done by immersing the bearing in boiling caustic soda for 15–20 minutes, followed by washing in clean boiling water.

3. Heating.—Overheating, whether of the metal forming the bearing or of the shell or housing on to which the bearing is cast may produce a condition of temper brittleness in the shell or housing, particularly if either is made of steel, and must therefore be carefully avoided. It is also necessary to avoid the formation of scale or other surface deposits detrimental to the white metalling process. All heating, for whatever purpose, should therefore be done by means of suitable baths, the temperatures of which can be maintained and controlled with the necessary accuracy. One of the baths usually contains old white metal and is employed for running out old metal from bearing shells, heating jigs, etc.

4. Tinning.—(i) Prior to the actual tinning of the surface on to which the white metal is to be cast it is usual to guard against the tinning adhering elsewhere by painting all other surfaces with Hall's distemper or a similar compound and allowing to dry ; the coating may be hardened by gentle warming to a temperature of about 50°C. While the process of tinning always follows the same lines the media used are not always the same. The materials employed are :—

(i) pure tin ;

(ii) tin—white metal ;

(iii) white metal ;

These may be used singly or together, e.g., one manufacturer may recommend tinning only with pure tin, whereas another may recommend a preliminary tinning with white metal followed by a further tinning with pure tin, whilst others may tin only with virgin white metal. An approved flux must be used to clean the surfaces to be tinned and also to prevent the formation of oxides ; the kinds most commonly in use are :—

(a) a compound of ammonium chloride, zinc chloride and sodium fluoride made up and used in the form of a dry powder.

(b) " Fluxite ".

(ii) After cleaning, the bearing to be tinned should be immersed in a bath maintained at the correct temperature. This temperature will b 350° C. when tinning with white metal and 240° C. when tinning with pure tin.

(iii) On reaching the temperature of the bath, the shell or housing should be removed, well " fluxed ", re-heated and then rubbed all over with a stick bearing the tinning medium, the process being repeated until the whole surface is evenly covered (the application of a scraper or file may be necessary to ensure evenness, but it should normally be sufficient to use a copper scalpel).

5. Metalling jig.—The jig required as a mould for the white metal should be designed with a view to influencing the cooling of the white metal after the bearing has been cast. It is very desirable that the white metal should start to " freeze " where it is in contact with the shell or housing. This is usually encouraged by varying the mass of metal in the jig ; the portion in contact with the shell or housing being comparatively light, while that forming the moulding surface is made comparatively heavy. Further control is obtained by variations in the temperatures to which the different parts of the jig are raised prior to assembly in readiness for pouring the bearing ; these temperatures are generally of the order of 240° C. for the light portion and 350° C. for the heavy, the tin bath being used for the former and the " old " white metal bath for the latter. The jig should also be designed to provide a reasonable " header " on the cast bearing wherein any shrinkage or other defects may be concentrated and which can be subsequently machined away, leaving the actual bearing perfectly sound.

6. Pouring the white metal.—It is very important that only sufficient white metal for the job in hand should be heated up. Heating should be done in a small crucible, preferably one provided with a scum arrester and pouring lip, which should be immersed in the bath of old white metal. It is important that the metal should not be kept in the molten state for longer than is absolutely necessary, but should delay in pouring occur after the melting, a layer of charcoal or wood ash should be floated over the surface to prevent oxidation and volatilisation, particularly of the tin constituent. Immediately before pouring, the metal should be thoroughly skimmed and stirred. On filling the bearing care should be taken to avoid the formation of bubbles. After pouring, the head of the white metal should be " puddled " with a length of steel wire, the " puddling " being confined to the part of the bearing remote from the shell or housing. Shrinkage should be made good by the addition of more metal.

7. Tests for adhesion.—All bearings should be tested for adhesion of the white metal. The following are the usual tests :—

(a) *Ringing test.*—This test is satisfactory only for those bearings in which the white metal is not keyed to the shell or housing by means of holes or grooves in the shell. A bearing should ring true when balanced on the fingers and gently tapped with a light hammer.

(b) *Hot oil test.*—After rough machining, the bearing should be immersed in hot oil, wiped dry and, while still hot, dusted over with french chalk. When thoroughly cold, any lack of adhesion around the edges, particularly at corners and keyways, will be evident by discolouration of the chalk where oil has exuded from the bearing during cooling. Porosity will also be disclosed by this test.

(*c*) *Chipping tests.*—This test is applicable only to production work. It consists of selecting one bearing from (approximately) every twenty bearings cast and chipping out the white metal by means of a cross cut cold chisel about $\frac{5}{16}$ in. wide. If the bearing is sound it should be possible to cut grooves through the white metal and into the base metal, but if it is unsound the white metal will come away freely from the base to which it has been cast; in the latter case, two more bearings should be tested and if either of these discloses incomplete adhesion the batch should be rejected and investigation made with a view to discovering and eliminating the cause of the failure. Should the two additional bearings both be satisfactory the remainder of the batch may be accepted.

INSPECTION LEAFLET ~~141~~ 430

CLASSIFICATION OF STEELS

1. General.—(i) Apart from a small number of special steels, the bulk of the steels used in aircraft and aero engine construction may be grouped under the following generic headings :—

(*a*) Carbon steels.

(*b*) Alloy steels (e.g., nickel 3·0 to 4·5 per cent., chromium 0·5 to 1·5 per cent.).

(*c*) Stainless (non-corrodible steels).

(ii) Group (*a*) may be sub-divided into mild, medium and high carbon steels, according to the carbon content.

(iii) Group (*b*) may be sub-divided into medium high tensile and high tensile steels, according to the composition and heat treatment applied.

(iv) Group (*c*) may be sub-divided into the simple or standard 12 per cent. chromium. the " Two-score " and the austenitic classes of non-corrodible steels (*see* para. 3 below).

2. Specifications.—(i) The compositions stated in B.S. and D.T.D. specifications are the same for a number of steels, the different physical characteristics required by each specification being obtained by cold work, heat treatment or a combination of these two factors.

(ii) It may happen that a contractor orders material in the rolled or softened condition to one of a group of specifications for subsequent heat treatment to meet the physical test requirements of another specification in the same group. In this event it is essential that the inspector at the works where the heat treatment is applied shall verify, by representative testing, that after such heat treatment the material fulfils all relevant requirements of the appropriate specification.

(iii) Resident and supervising inspectors are responsible for ensuring that all material is in the condition specified in the relevant materials schedules or drawings before it is finally embodied in aircraft or aero engines.

See inspection Leaflet 407 689426/37

3. Notes on non-corrodible steels to B.S. and D.T.D. specifications.—(i) The simple (or " standard ") 12 per cent. Cr. non-corrodible steel contains up to 1·0 per cent. of nickel and not less than 12 per cent. of chromium. It is magnetic and may be hardened by heat treatment. This class of steel is referred to in D.T.D. specifications as non-corrodible steel.

(ii) " Two-score " non-corrodible steel contains from 1 to 3 per cent. of nickel and 16 to 20 per cent. of chromium. It is magnetic and may be hardened by heat treatment. This class of steel is referred to in D.T.D. specifications as high chromium non-corrodible steel.

(iii) Austenitic non-corrodible steel (known as " Staybrite " or " 18/8 ") contains not less than 6 per cent. of nickel and not less than 12 per cent. of chromium. For practical purposes it is non-magnetic and can be hardened only by cold working. This class of steel is referred to in D.T.D. specifications as chromium nickel non-corrodible steel.

(iv) The simple 12 per cent. Cr. non-corrodible steel should not be used in direct contact with non-corrodible steel of the Austenitic composition, although either may be used in contact with non-corrodible steel of the " Two-score " type.

INSPECTION LEAFLET 142

PROTECTION OF EXHAUST MANIFOLDS AND STUB PIPES BY THE METALLISATION (ALUMINISING) PROCESS

1. **General.**—The metallisation (aluminising) process is patented and consists of spraying molten aluminium on the part to be treated and then alloying the aluminium to the steel by means of suitable heat treatment. Unless otherwise sanctioned, the process must not be applied to parts other than exhaust manifolds and stub pipes. It must always be applied in its entirety.

2. **Preparation of parts for processing.**—(i) Sand-blasting is the only satisfactory method of preparing the surface for metal spraying. During sand-blasting a gauge pressure of between 27 and 30 lb. per sq. in. should be maintained, and a hard angular sand, such as black flint sand, washed and crushed, should be used. The sand should be screened to 20 mesh per in. and must be dried before use. Alternatively, the steel grit known as " No. 24 " may be used, but it must be angular, not round, and should be replaced immediately the corners show signs of rounding. When steel grit is used the gauge pressure should be reduced to between 24 and 27 lb. per sq. in.

(ii) The sand-blast jet should be kept between 5 in. and 7 in. from the work. Between sand-blasting and spraying the manifolds must be handled only with clean rubber gloves.

(iii) All areas not to be treated should be protected with rubber tape which is capable of resisting both sand-blasting and metal spraying.

3. **Inspection after sand-blasting.**—After sand-blasting, the parts are to be examined, and if any moisture or oil is detected they should be heated to 120° C. in a suitable oven and afterwards re-sand-blasted. The surface of the parts must be free from all traces of scale, rust, grease or moisture before they are sprayed.

4. **Spraying.**—(i) The deposit must be free from lumps and coarse areas and must be applied without interruption within a few minutes of sand-blasting. It must be uniform, with a weight per sq. ft. of not less than 1½ ozs. and a thickness at any point of not less than 0·007 in.

(ii) The coating of aluminium is sprayed by means of a wire-fed gas-heated metal spraying pistol of approved design. The wire used is commercially pure aluminium (i.e., purity not less than 99 per cent.), 1 mm. in diameter, and is wound on reels suitable for feeding the pistol. The rate of feed should be approximately 15 ft. per minute. The gases supplying the pistol must be reasonably dry. The distance between the pistol nozzle and the work should be from 3 in. to 5 in.

5. **Treatment after spraying.**—(i) After spraying, and checking the weight of deposit, the parts are to be coated with bitumastic paint and subjected to the following treatment :—

(*a*) They are to be placed in a furnace of the enclosed muffle or semi-muffle type which has been heated (by oil, gas or electricity) to a temperature of 800° C. The heat is then to be shut off and the temperature allowed to fall either until it reaches 650° C. or for 20 minutes, whichever period is shorter, when the manifolds are to be removed and allowed to cool in air. (The subjection to a falling temperature is an important feature.) When necessary, suitable jigs are to be used to prevent distortion during the heat treatment.

(*b*) The parts are then to be burnished by revolving brushes with steel wire bristles. Areas not accessible by mechanical brushes are to be carefully brushed with a band scratch brush. Bristles of 36 S.W.G. are recommended.

(iii) The finished surface should be of a uniform silvery appearance, free from dark areas or blisters.

INSPECTION LEAFLET 145

WELDING OF AERO ENGINE PARTS

1. General.—The welding of aero engine parts must be done under approved conditions, and the inspector is responsible for ensuring that these conditions are maintained.

2. Approved conditions.—Since the inspection of a finished weld is mainly confined to a visual examination, the inspector has to rely upon the maintenance of the approved conditions. The approved conditions include the following :—

(i) the use of approved materials ;
(ii) the approval, and maintenance, of the standard of efficiency of the welders ;
(iii) the use of approved methods.

3. Materials.—(i) The inspector must verify that the materials to be welded are approved for such process and are as shown on the appropriate drawing, and that any flux used in the process is of approved type.

(ii) If the relevant drawing is not endorsed to the effect that heat treatment may be omitted, parts made of ferrous material must be heat treated after welding, except that non-corrodible steels to D.T.D. Specifications Nos. 171, 176 and 207 may be used in the " as welded " condition and that edge and spot welding are permitted on non-corrodible steel to D.T.D. Specification No. 166 without subsequent heat treatment, but in this latter case it should be noted that the steel will be reduced in strength in the vicinity of the weld to that of steel to D.T.D. Specification No. 171.

(iii) All steels other than those of the non-corrodible kind must be welded with iron or mild steel wire to D.T.D. Specification No. 82 or with a rod or strip of approximately the same composition as the material being welded.

(iv) Non-corrodible steels must be welded with rods or strips of approximately the same composition as the material being welded, or with rods to D.T.D. Specification No. 61.

(v) The heat treatment referred to in sub-para. (ii) must be that which is defined in the relevant material specification. Local application of heat, such as flame normalising, is not permitted for heat treatment purposes. Details of the necessary temperatures should be obtained from the relevant release notes.

4. Personnel.—The inspector must verify that all persons engaged in the welding of aero engine parts, other than those which do not affect safety (e.g., certain types of end plates, starter control brackets, etc.), have been proved competent to perform this operation. The proof shall take the form of a satisfactory report by the A.I.D. Test House No. 2, Cardington, upon standard test specimens, prepared by each welder. For further instructions, *see* Appendix A.

5. Methods.—(i) *The oxy-acetylene process.*—The inspector must verify that pure gas is employed. When gas generators are used it is necessary to make a daily test of purity by means of blotting paper saturated with a 10 per cent. solution of silver nitrate. When dissolved acetylene gas is used the test for purity may be made at longer intervals. The flame must be as nearly neutral as possible. As a perfectly neutral flame is difficult to recognise it is usual to weld with a flame carrying the smallest observable excess of acetylene. This condition is realised when the blue cone nearest the jet carries a slight fringe or feather of white flame.

(ii) *Other methods of welding.*—Alternative methods must be approved by the Air Ministry.

6. Final visual inspection.—The inspector must verify so far as is possible by visual examination that :—

(i) the material added from the welding rod forms a regular fillet ;

(ii) satisfactory fusion has been achieved ;

(iii) the fusion zone is free from cracks, porosity and burning ;

(iv) the material is not reduced in thickness by the welding operation ;

(v) all welds are left in the " as welded " state and that no attempt has been made to clean them by filing, grinding, or machining before inspection.

APPENDIX A

(i) As a proof of competency, each welder is required to make up standard test pieces of the form and dimensions shown in figs. 1 and 2 of the appendix to Inspection Leaflet 89. These specimens have been devised so that, by cutting, they are readily adaptable for both physical and micro examinations. The test pieces are standard for all materials upon which welding is done, and the proof of competency will be required for each material. The procedure to be followed is outlined hereunder.

(ii) All test pieces will be made under the supervision of the approved firm's inspector. If the welder is dissatisfied with the quality of his work on any test piece he is to be free to produce others, the sole condition being that those finally submitted for examination must have been produced under the inspector's supervision.

(iii) Both halves of each test piece shall be marked to identify the welder. Provided that the approved firm's inspector is satisfied by a visual examination that the welds are acceptable, he will impress his stamp and dispatch them to the Air Ministry inspector supervising his firm with a formal request for approval. The full name of the welder must be given in the application.

(iv) The supervising inspector will examine the specimens and, if he considers them fit for test, will dispatch them to A.I.D. Test House No. 2, Cardington, under cover of the normal application for test, recording thereon the names of the firm and the operator and a statement that samples are submitted in accordance with Inspection Leaflet No. 145. The specimens should not be dressed or sand-blasted. The nature of the filler rod used should be stated.

Note.—Heat treatment is not required on samples other than those made up from stainless non-austenitic steel ; with these latter the heat treatment indicated by the specification or release note is to be given prior to submitting them for test.

(v) If any specimen submitted for test is found to be unsatisfactory, the welder concerned should be allowed to submit a fresh set, provided that he or she has had an opportunity of acquiring additional experience in the welding of unimportant (unstressed) parts in the meantime.

(vi) As regards persons who had been employed as welders for a considerable period prior to the issue of this leaflet, and of whose skill there is no doubt, the firm's approved inspector will refer to the supervising inspector, who may use his discretion as to whether such persons must submit specimens of their work for test and, if he considers this to be unnecessary, shall record his approval of each welder concerned, and notify the Inspector-in-charge, A.I.D. Test House.

(vii) Each welder's work should be checked once every six months by testing samples of work done in the ordinary course of events. If the operator whose work is to be checked is engaged on parts that are too costly to be taken for test, it may be possible to arrange that he shall work on other parts, of which a sample can be taken.

(viii) A check test should also be made whenever a welder is required to work on a material other than that to which he has been accustomed over a lengthy period.

(ix) Records of approved welders at civil aircraft engine firms will be maintained at the A.I.D. Test House No. 2, Cardington, and by the supervising inspector.

This sheet issued November, 1938,
with A.L. No. 4 *to A.P.* 1208.

INSPECTION LEAFLET 148*

DE HAVILLAND—HAMILTON METAL AIRSCREWS

(Two pitch and constant speed types)

1. General.—(i) Airscrews of the above-mentioned types must be inspected to verify that they are made in accordance with an approved design and of materials which comply with the relevant specifications, and that their detail parts bear all the requisite markings. The heat-treatment and other processes to which materials are subjected must be in accordance with any specifications and inspection leaflets applicable thereto.

(ii) The inspector must ensure that the progress of manufacture and inspection is recorded at the stages tabulated in Appendix I.

(iii) Detailed requirements in connection with the inspection are dealt with in succeeding paragraphs.

2. Heat-treatment and testing of forgings.—The inspector must verify that:—

(i) each forging is correlated with the corresponding release note ;

(ii) samples prepared in accordance with the relevant specification are identified and included with the forgings which they represent during the heat-treatment and ageing process and thereafter subjected to the specified mechanical tests ;

(iii) blade forgings fitted with thrust rings are quenched in oil at a temperature not less than 40° C. or (if the thrust rings are suitably protected by an aluminium cowl) in water at a temperature not less than 80° C. ;

(iv) no evidence of overheating appears from the microscopical examination of a specimen cut from the root end of each blade forging after the up-ending operation.

(v) any impairment of the heat-treated condition of a part in the course of manufacture is corrected by fresh heat-treatment.

3. Shaping of blade forgings.—The inspector must verify that :—

(i) each forging provides a sufficiency of material for the stem, profile and aerofoil section and that all visible defects in the material or forging have been discovered ;

(ii) any necessary bending or twisting of the forging does not exceed that allowed by Appendix II, para. 1, unless it is done either (*a*) not more than two hours after quenching, or (*b*) after the forging has been softened at a temperature of from 360° C. to 400° C. (in the latter case the forging must subsequently be heat-treated and the requirements of paras. 2 (ii) and 2 (iii) of the leaflet fulfilled) ;

(iii) the correction of edge alignment is done only with the forging at a temperature of from 400° C. to 450° C. and that the forging is afterwards heat-treated and the requirements of paras. 2 (ii) and 2 (iii) fulfilled.

4. Finish : dimensional and other checks : anti-corrosion treatment.—The inspector must verify that :—

(i) each blade, when shaped and polished, exhibits a satisfactory standard of finish and is free from scratches and other defects, such as imperfectly-smoothed depressions ;

(ii) the dimensions, track, angles, face and edge alignment of each blade, and its fit to templates, conform to the relevant drawings ;

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* This leaflet will take effect as from 1st January, 1939. (741772/38.)

Inspection Leaflet 426
This sheet issued May, 1938,
with A.L. No. 3 to A.P.1208.

INSPECTION LEAFLET 426

(Previously No. 35)

CONTROL OF HEAT TREATMENT OF DURALUMIN RIVETS

1. General.—Duralumin rivets are to be employed in the finally heat-treated condition only. In order that the rivets may be in a suitable state for satisfactory closing it is essential they should not have hardened by ageing to an extent which would render riveting difficult or impracticable. It is necessary therefore that control of the rivets should be maintained from the time of their issue from the stores until they are actually fastened in an aircraft structure. The control must provide a ready check that the agreed maximum permissible period of ageing after heat treatment has not been exceeded. The precautions taken with bulk quantities of rivets are also to be taken with small quantities of rivets which may be used for experimental work, repairs, alterations, etc.

2. Heat treatment.—(i) The specified requirements relative to the heat treatment of duralumin generally are to be observed, and an effective control established which will verify that the final heat treatment (normalising) is applied in accordance with the specified requirements. It is a general requirement that duralumin is to be worked within two hours of final heat treatment. Some latitude however may be permitted in this connection in respect of rivets. With a normal working day of eight to nine hours it will suffice if two heats take place in the morning and two in the afternoon, even though the two hours period is slightly exceeded. The times of the final heats should be so arranged that issue of the rivets to the shops is made with a minimum of delay before use. Close attention is to be given therefore to the system of distribution, which must prevent supplies of aged rivets being used by operatives, and must make it obvious to all concerned should rivets be employed after expiry of the agreed ageing period. An approved system which will give the required control is described below. Other systems may be approved to meet local conditions, provided they give an equivalent safeguard.

(ii) The times for heat treatment and the periods over which treated rivets are to be employed will be agreed by the supervising inspector.

(iii) A colour will be selected to indicate each time period and containers in which rivets are issued to the shops will be marked accordingly, preferably by being coloured all over (but adhesive labels may be used).

(iv) Issues of rivets to the shops will be made only through the heat treatment shop, and in coloured containers.

(v) The person responsible for the issue of rivets from the heat treatment shop will also be responsible for ensuring that all unused rivets from previous heats have been collected, and that they are so disposed of as to prevent them being re-issued without the necessary further heat treatment.

* (vi) An alternative to the heat treatment of rivets in batches throughout the day is provided by the refrigerating process. If advantage is taken of this, the whole of a day's supply of rivets may be treated at one time. The inspector must verify that the following requirements are fulfilled :—

(*a*) The rivets are to be transferred to the refrigerator immediately after they have been quenched, washed and drained. (Thorough drying is not essential, but if put in hand it must be completed as quickly as possible and at a temperature not above 70° F.)

(*b*) The refrigerating temperature is to be kept within the range –15° C. to –20° C. or 0° C. to –5° C. At the lower temperature the maximum storage period is 150 hours; at the higher temperature it is 45 hours.

(*c*) Rivets in the refrigerator at the conclusion of the maximum storage period are to be taken out and re-subjected to heat treatment.

(*d*) Refrigerated rivets not used within 2 hours after their removal from cold storage must be re-subjected to heat treatment.

(*e*) The distribution of the rivets must be controlled as specified above.

(*f*) The date, period and temperature of refrigeration of each batch of rivets are to be recorded to the satisfaction of the supervising inspector.

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* This amendment will take effect as from 1st May, 1938. (687810/37.)

Inspection Leaflet 432
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INSPECTION LEAFLET 432

(Previously No. 112)

INSPECTION OF FLEXIBLE STEEL WIRE ROPE

1. General.—The inspection of flexible steel wire rope must be directed towards ensuring that :—

(i) the steel wire complies with the requirements of the relevant specification and has the tensile strength specified by the manufacturer of the wire rope ;

(ii) the finished rope complies with the requirements of the relevant specification.

2. Inspection of steel wire.—(i) The inspector must ensure that the steel rods have been obtained from an approved source and are covered by a release note, and that the cast number and release note for each coil of rod and each coil or hank of drawn wire can be ascertained without any difficulty.

(ii) Each coil or hank of wire is to be inspected for size, defects and continuity of the protective coating, and tested for compliance with the physical requirements of the relevant specification and the tensile requirements specified by the manufacturer of the wire rope. The physical tests required are :—

(*a*) tensile test ;
(*b*) torsion test ;
(*c*) wrapping test.

Note.—During the torsion test the wire should not split or show surface defects. It should twist uniformly throughout its length.

(iii) All coils and bundles of wire must be examined prior to despatch to verify that the information required by the " marking " clause of the specification is on the labels attached to them.

(iv) Before wire is issued for rope construction the inspector must see the relevant release notes and test reports.

3. Inspection of strands and finished rope.—(i) A process inspection on all strands must be made before the closing operation, to ensure correctness of construction and freedom from loose wires, kinks or irregularities. Particular attention is to be paid to the requirements of the specification in respect to jointing. The finished rope is to be tested and inspected for :—

(*a*) breaking strength ;
(*b*) construction ;
(*c*) diameter ;
(*d*) weight ;
(*e*) uniformity of lay.

(ii) The finished rope should present a clean and solid appearance and each strand should appear to have an equal tension.

Note.—Great care is to be exercised in unwinding flexible wire ropes for inspection and in re-winding them. For either operation the drum should be mounted on a spindle and the rope kept taut and parallel to the ends of the drum to prevent it slipping off, with a consequent risk of its kinking or " birdcaging."

4. Defects.—(i) The following typical defects are illustrated in the attached figs. 1–4 :—

Fig. 1.—One strand without centre caused by centre bobbin running out during stranding operation.

Fig. 2.—One slack strand caused by slack nips on stranding machine.

Fig. 3.—Faulty closing showing a proud strand.

Fig. 4.—Crossed strands.